SUGARBEET RESEARCH

1979 REPORT

A Report to and for
the Sole Use of Cooperators
NOT FOR PUBLICATION

FOREWORD

SUGARBEET RESEARCH is an annual compilation of progress reports concerning incomplete research by Science and Education Administration investigators and cooperators who are engaged in sugarbeet variety and production research. The report has been assembled by Dr. John S. McFarlane, Technical Advisor for sugarbeet breeding. The report has been reproduced at the expense of the Beet Sugar Development Foundation, and is for the sole use of the cooperators. Much of the data has not been sufficiently confirmed to justify general release and interpretations may be modified with additional experimentation. The report is not intended for publication and should not be used for cited reference nor quoted in publicity or advertising. Reproduction of any portion of the material contained herein will not be permitted without the specific consent of the contributor or contributors.

The report presents results of investigations strengthened by contributions received under Cooperative Agreements between Science and Education Administration, U.S. Department of Agriculture, and the Beet Sugar Development Foundation; the California Beet Growers Association, Ltd.; the Farmers and Manufacturers Beet Sugar Association; and the Sugarbeet Research and Education Board of Minnesota and North Dakota.

Trade names occur in this report solely to provide specific information and do not signify endorsement by the U.S. Department of Agriculture or the Beet Sugar Development Foundation.

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SUGARBEET RESEARCH

1979 Report

Section A

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Holly Sugar Corporation
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Union Sugar Division
California Beet Growers Association

The research was supported in part by funds provided through the Beet Sugar Development Foundation (Projects 11, 12, 24, and 29) and the California Beet Growers Association.

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SUMMARY OF ACCOMPLISHMENTS, 1979

COMPARISON OF S_1 AND TEST-CROSS EVALUATION AFTER ONE CYCLE OF SELECTION IN SUGARBEET--Synthetics derived from a monogerm, self-fertile, random-mating population were re-evaluated in field tests in 1979. These synthetics were initially evaluated at Salinas and Brawley in 1978 (pages A52-A61, 1978 Sugarbeet Research Report). These cycle 1 synthetics were produced to evaluate the ability of S_1 and test-cross (TX) evaluation procedures to discriminate S_0 genotypes for high and low sugar yield (SY) and % sucrose. The 1979 performance of these synthetics per se was nearly identical to that measured in the 1978 tests. In comparison to an equivalent, but unselected synthetic, selections for high and low SY by S_1 evaluation resulted in a highly significant increase and decrease of 14.0% and 9.4%, respectively (Test 1179-1, page A32). Synthetics based upon TX evaluations for high and low SY showed changes of 6.5% and -3.5%, respectively. Selections for high and low sucrose content by S_1 evaluation produced significant changes of 7.2% and -5.2%, respectively, for sucrose content. The results of 1978 and 1979 tests of the synthetics per se showed that S_1 evaluation had greater efficacy than TX evaluation at identifying S_0 genotypes.

In 1978, stecklings from the cycle 1 synthetics produced in this selection experiment were planted in an isolation plot, rogued to genetic male-sterile plants, and crossed to the tester Y631E. These experimental hybrids were evaluated for yield performance in tests 1179-2 at Salinas and B479 at Brawley (pages A33 and A47). The results from these tests are much less striking than those from the evaluation of the synthetics per se. In the test at Salinas, the synthetics based on S_1 and TX evaluation for SY did not exhibit significantly improved combining ability. The results of these hybrid tests do not provide very persuasive evidence for either S_1 or TX evaluation as a method to identify combining ability differences among S_0 genotypes. R. T. Lewellen and I. O. Skoyen.

POPULATION IMPROVEMENT OF MONOGERM GERMPLASM--Recently, Dr. R. S. Loomis, Plant Physiologist, UC-Davis, suggested that the main objectives in sugarbeet breeding can be divided into (1) defect elimination, (2) genetic structure, and (3) yield. The ultimate priority is for increased sugar yield but lines superior in yield capacity may have limited usefulness if they are susceptible to prevalent diseases or have a genetic structure that precludes their use. A comprehensive breeding strategy could be one that initially involved population improvement based on defect elimination, e.g., disease resistance, and that modified the population to fit a particular genetic structure, e.g., to be monogerm and type-O. These improved populations could then serve as the base for extracting and evaluating lines for improved yield capacity. Currently, this procedure is one of the breeding methods that we are using to improve monogerm, type-O germplasm. However, for this breeding procedure to be fully functional, genetic variability and recombination need to be maintained from cycle to cycle. Within our self-fertile monogerm germplasm, genetic male sterility has been incorporated to facilitate random mating. These self-fertile, random-mating populations thus provide the advantages of both self-fertility (e.g., to select and fix the monogerm and type-O traits, to maintain S_0 genotypes with selfed seed, etc.) and self-sterility. A number of self-fertile, monogerm, male-sterile-facilitated random-mating

populations have been developed at Salinas. As these populations are developed and improved, it is useful to evaluate them and to identify their potential as sources from which to concentrate specific breeding efforts.

Performance of random-mating populations--The performance of 10 populations evaluated in 1979 are summarized in tests 1079 and 2179 (pages A31, A40, and A). These self-fertile, random-mating populations represent a moderately broad germplasm base with general adaption to the Far West. Most of these populations have had multiple cycles of selection for virus yellows and/or erwinia soft rot and are moderately resistant to curly top. All are monogerm and most have a moderate to high frequency of type-O plants. Test 2179 shows that most of these populations are significantly more resistant to BWYV than either 546H3 or US 75 and some approach the yellows resistance of C36. In the absence of severe disease, these populations have better sucrose concentration than C36 and under BWYV infected conditions, most are significantly better for sucrose than either C36 or 546H3. The 755 (6755, 7755, or 8755) population which has had the best per se performance of these populations also has produced the best yields in variety hybrids with C17 and C31E. In some tests, these hybrids have had significantly higher sugar yield than the corresponding C17, C36, and C31E1 hybrids with 546H3.

Performance of random-mating populations in variety hybrids--During the development of the self-fertile random-mating populations, near-equivalent CMS phases were produced. Seven populations in which near-equivalent CMS's are available were evaluated in Tests 979 and B579 (pages A30 and A48) as variety hybrids with C31E1 as the tester. Hybrids produced on corresponding genetic and cytoplasmic male sterile phases were compared to appraise these populations for general combining ability. In the tests at Salinas and Brawley, there were no overall differences between the CMS and a_1a_1 hybrids for sugar or beet yield. Neither was there a significant interaction between types of sterility. Therefore, it should be possible to use genetic male sterility to evaluate the combining ability of early generation lines extracted from these populations without undue concern that differences in performance will be expressed at a later time when the CMS phase may be used to produce commercial hybrids. The yield of the population or variety hybrids may also be useful to identify the mean general combining ability of different populations and indicate which improved random-mating population should be chosen for advanced or recurrent selection methods. For example, in 1978 and 1979 tests at both Salinas and Brawley, the hybrids with the 755 population had better performance than US H10. Although the 755 population is still in need of being improved for type-O, nonbolting tendency, and possibly disease resistance, these data suggest that superior lines extracted from 755 and hybridized with C17, C36 or other pollinators should produce hybrids with significantly improved performance. R. T. Lewellen and I. O. Skoyen.

COMPARISON OF US H10B AND US H11--Seedlots of US H10B and US H11 were evaluated in 11 USDA tests (9 at Salinas and 2 at Brawley) in 1979. As the following summary shows, US H10B was slightly superior to US H11 for sugar yield. Although in no single test was US H10B and US H11 significantly different, US H10B ranked above US H11 in sugar yield and % sucrose in 10 of 11 comparisons.

Comparison of US H10B and US H11 in 11 USDA tests in 1979

	Acre Yield		%	% Rot/
	Sugar (lbs)	Beets (T)	Sucrose	Beet*
US H10B	9,240	32.5	14.1	34.0
US H11	8,960	32.2	13.8	5.7

*Mean of 2 injury-inoculated tests involving 7 comparisons.

These results are somewhat different from the previous comparisons between US H10B and US H11 involving 19 tests from 1976 through 1978 in which US H11 was usually slightly superior to US H10B.

Comparison of US H10B and US H11 in 19 tests from 1976 through 1978

	Acre Yield		%	% Rot/
	Sugar (lbs)	Beets (T)	Sucrose	Beet*
US H10B	9,970	36.5	13.6	23
US H11	10,170	37.1	13.7	4

*Mean of 6 injury-inoculated tests.

The background level of Erwinia resistance in breeding lines and hybrids involved in our testing program has been significantly improved in the last year or two and the incidence of roots with soft rot has dramatically decreased. In the 1979 tests at Salinas and Brawley, erwinia soft rot did not appear to influence yields, whereas in the 1976 to 1978 period, many tests had moderate levels of infection in susceptible entries. These 1979 data appear to be consistent with the comparisons made between US H9 and US H10 in the late 1960's and early 1970's when these hybrids were being extensively tested. Thus, it appears that in the near absence of Erwinia US H10 may have a slight advantage over US H11 as it did over US H9. R. T. Lewellen, I. O. Skoyen, and E. D. Whitney.

YELLOWS RESISTANT GERMPLASM--One of the constraints limiting the development of higher yielding hybrids with improved purity adapted to California and Arizona conditions has been the narrowness of the yellows resistant (YR) germplasm. Until recently, yellows resistance was essentially limited to a few specific sources, particularly C13 and C17 which are relatively closely bred selections from US 75. As the data in Test 2079 (pages A38 - A39) suggest, the YR germplasm has recently been broadened and now encompasses a fairly diverse background. For example, lines Y840 and Y846 were derived from crosses between C17 and C64. Y831E combines curly-top resistant germplasm from California and germplasm from several European sources. Y841 was selected from crosses between C01 and C64. Y842 involves germplasm from C17, C64, and Europe. Y839 was derived from composite crosses involving germplasm from C17, C01, C534, C64, C921, C85, US 15, US 56/2, SP6822-0, FC701/2, FC702/2, and several European sources. Each of these breeding lines have certain specific strengths and weaknesses but in general all have moderate to good levels of yellows resistance and moderate resistance to erwinia soft rot. These lines differ in their nonbolting tendency but NB selections that should improve this characteristic were made in several of these lines in 1979.

These lines show considerable variability for resistance to powdery mildew and Y839 and Y841 appear to be moderately resistant. These lines per se have equal or better tonnage and sucrose content than C17 or C36 and are currently being evaluated for combining ability. The greatest weakness of this set of multigerm lines is their level of curly-top resistance that ranges from moderately susceptible to that equal to C17. Hopefully, these lines will ultimately offer a broader based source of YR germplasm from which lines with significantly improved combining ability and other disease resistance can be extracted. R. T. Lewellen, I. O. Skoyen, and J. S. McFarlane.

SELECTION FOR RESISTANCE TO BWYV--In 1977, several breeding lines were selected for resistance to BWYV rather than a combination of BYV and BWYV. The first opportunity to evaluate these selected lines was in 1979 (Test 2079, pages A38 - A39). In comparisons between two of the selected lines and their sources it appeared that one cycle of mass selection for resistance to BWYV was effective.

Results of one cycle of selection for resistance to BWYV

	Sugar Yield (lb/A)			Yellows	Beet Yield (T/A)		% Sucrose	
	Check	BWYV	% Loss	Score	Check	BWYV	Check	BWYV
Y841-Y1	9,380	9,030	3.1	3.0	31.2	30.5	15.0	14.8
Y741-Y0	9,070	8,140	10.4	4.4	31.1	28.3	14.6	14.4
	NS	*	NS	*	NS	*	NS	NS
Y831E-Y1	9,280	9,110	3.0	2.8	30.4	29.1	15.3	15.5
Y731-Y0	9,000	8,300	7.4	3.4	30.7	28.3	14.7	14.7
	NS	*	NS	NS	NS	NS	*	*

*Significantly different at least at the 5% level.

For the Y41 line, sugar yield and beet yield were significantly improved by selection when evaluated under BWYV conditions but not when evaluated under noninoculated conditions. The Y31 line was significantly improved for sugar yield under BWYV inoculated conditions. In this test, % losses for sugar yield were not significantly different but were reduced by resistance selection for both lines. The disease symptoms or yellows scores were also lower in the selected lines. Although their nonselected sources were not included in this test, it appeared that selection for BWYV resistance also was effective for other breeding lines, e.g., Y839, Y842, and Y846. With the apparent improvement in resistance to BWYV in a single cycle of selection, these results also would suggest that the heritability for resistance to BWYV is much higher than it is for resistance to BYV. When correlations are run between individual roots infected with BWYV, the correlation coefficients are usually positive between root weight and sucrose content rather than being negative which is the usual relationship in nondiseased plants. Mass selection for resistance to BWYV in which gross sugar yield is used as the selection criterion thus appears to be an effective breeding procedure. When breeding lines have been evaluated and selected for resistance to BYV and/or BYV-BWYV, in most cases, lines resistant to one virus were usually resistant to the other. It will now be of interest to re-evaluate these BWYV resistant selections to determine if resistance to BYV has also been improved or whether different resistance genes and host-plant resistance mechanisms are involved. R. T. Lewellen, I. O. Skoyen, and J. S. McFarlane.

EVALUATION OF COMMERCIAL HYBRIDS TO BWYV--Commercial sugarbeets planted in all beet growing districts of California and Arizona are subject to virus yellows infection. The effectiveness of beet-free-periods has greatly reduced the incidence of BYV but BWYV with its wide host range and persistent aphid transmission remains a constant hazard. Commercial hybrids that were developed outside of California and that have no known yellows resistant component were evaluated to estimate the potential losses to BWYV. The results presented in Test 1879 (pages A34 - A35) suggest that the losses caused by BWYV infection will be 2 to 3 times greater in yellows susceptible hybrids than in moderately resistant hybrids. The hybrids from Great Western, Hilleshog, and Betaseed which had more or less been randomly chosen for this test had losses of 30 to 32% for gross sugar yield, or in this test, a reduction of approximately 2,600 pounds of sugar. R. T. Lewellen and I. O. Skoyen.

RESISTANCE TO ERWINIA--A breeding program to select for resistance to erwinia soft rot was continued in 1979. Resistance selections were made in 18 breeding lines. In addition, approximately 120 breeding lines and hybrids were evaluated in two injury-inoculated tests. The Erwinia resistance program is summarized on pages A54 - A59 of this report. R. T. Lewellen, E. D. Whitney, and I. O. Skoyen.

RESISTANCE TO POWDERY MILDEW--Reactions of sugarbeet lines to powdery mildew (PM) have been moderately well correlated between field and greenhouse evaluations. Also, within line variability for PM reactions have been evident in greenhouse tests. These factors have suggested that PM resistance selection based upon greenhouse evaluations should be feasible. Breeding lines Y31, Y41, and Y46 which showed variability for PM reaction in the field were chosen as parental sources to test the effectiveness of greenhouse selection. In the first cycle of selection, the most resistant segregates were selected and crossed in pairs. In the 2nd cycle of selection, resistant plants from the best full-sib families were selected and crossed in pairs. Seed from these 2nd cycle families was harvested in the late spring of 1979 and planted in the field. PM was allowed to develop, and each family, their parental sources, and checks were scored four times from September 18 to October 5 on a scale of 0 to 9. Because of the late planting date and heavy fall dews, the disease severity was relatively mild. The mean reactions of the parental sources, their 2nd cycle families, and the C17 check are compared in the following table:

Breeding line	Mean reaction		Range of selected families
	Source	Selected families	
C17 (check)	4.6		
Y31	3.8	2.4 (13)*	1.3 - 4.0
Y41	2.3	1.1 (15)	0.5 - 2.0
Y46	4.4	2.4 (13)	1.3 - 4.0

Planted June 19, 1979. *Number of families evaluated.

The data in this table show that the average reaction for the 2nd cycle families have been improved compared to their parental sources. Several of the individual families expressed good levels of resistance. It thus appears that a relatively simple greenhouse evaluation and selection procedure can be used to breed resistance to PM in adapted germplasm. R. T. Lewellen and E. D. Whitney.

FUSARIUM STALK BLIGHT RESISTANCE--A stalk blight resistant selection from the widely used C563 inbred was increased at Salinas and designated C566. As the first step in the development of a male-sterile equivalent of C566, the selection was also crossed with a monogerm male-sterile line from the NB1 inbred. Evaluation tests at Salinas and Logan, Utah showed C566 to be similar to C563 in bolting, curly top, and powdery mildew resistance. Results of a stalk blight resistance test at Salem, Oregon are given on page A60. A Beet Sugar Development Foundation sponsored increase of C566 and of C566 CMS is being made at Salem in 1980. J. S. McFarlane.

FIELD EVALUATION OF ROOT TOUGHNESS (ROOT FIBER CONTENT)--1979 test results for two dates of seeding showed that plant age was a primary factor in root toughness as measured by ft. lbs. of pressure required for penetration of a probe. Mean root toughness in Test 1 (seeded November 1978) was 20.9 ft. lbs. pressure but in Test 2 (seeded February 1979) the mean was 17.9 ft. lbs. (pages A62 - A63). Bolting and seed stalk development did not appear to increase root toughness, at least prior to seed development and maturation. The progeny and hybrids of 1978 selections in four pollinator lines for both high and low probe values will be tested in 1980 field tests. I. O. Skoyen and R. T. Lewellen.

GERMPLASM PRESERVATION--Additional seed samples of wild Beta species were obtained from Europe. Greenhouse and field increases were made of 50 wild beet introductions including Beta maritima - 28, Beta macrocarpa - 4, Beta atriplicifolia - 6, Beta corolliflora - 2, Beta macrorhiza - 1, Beta trigyna - 1, Beta patellaris - 6, and Beta webbiana - 1. Many of these seedlots were found to be mixtures or to contain outcrosses. Attempts will be made in 1980 to rogue some of the lots and to produce noncontaminated seed of each species. Increases were also made of 34 Beta vulgaris lots including obsolete varieties, foreign varieties, and fodder beets. J. S. McFarlane.

CYTOLOGICAL STUDIES IN BETA SPECIES--The resistance transmission of the nematode resistant sugarbeets has so far been lower than expected. Self- or cross-pollination of the resistant heterozygous plants transmitted resistance to an average of about 41% of the progeny. In spite of the meiotic abnormalities of the parents a bred-true resistant family occurred in the S_2 generation. The transmission of nematode resistance was very much convincing for both the selfed and open-pollinated progenies of this family. This demonstrated that nematode resistant homozygotes in sugarbeet are viable and producible.

The nine chromosome sugarbeet plant investigated had a narrower leaf lamina and less vigorous growing profile. This plant contained chimeral sectors. At the first meiotic anaphase the nine univalents associated into two unequal groups and migrated to the poles in all possible numerical combinations. Some meiotic abnormalities were observed in the microsporocytes of this haploid plant. M. H. Yu.

ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION, 1979

DUFFUS, JAMES E. The ecology of yellowing viruses--Epidemiology and control of virus diseases of vegetables. Proc. 3rd Conf. of ISHS Working Group on Vegetable Viruses. 37-40. 1979.

After a brief historical survey of major diseases caused by yellowing viruses, i.e. the agents of disorders characterized by stunting of infected plants, accompanied by rolling, yellowing, reddening and brittleness of affected leaves, some aspects of their ecology are reviewed.

Virus inducing yellowing diseases have special affinities to the phloem. They fall into three distinct groups: viruses transmitted by whiteflies; semipersistent aphid-transmitted viruses with flexuous, filamentous particles and persistent aphid-transmitted viruses.

FALK, B. W. and JAMES E. DUFFUS. The role of mixed virus infections in epidemiology. In Ecology and Control of Vector-Borne Disease Agents of Plants. (Book Chapter) (In press). 1980.

The increased host range and ability to use various helper viruses suggests that LSMV and other dependent viruses could have very complicated epidemiological characters. Such theoretical possibilities were discussed in a review concerning dependent transmission. It has been demonstrated that LSMV may infect hosts that are not hosts of the helper, BWYV, and the same is true for some of the other dependent viruses. In this case, aphid transmissibility would cease. However, if another helper virus (luteovirus) were to infect this plant, it might then be able to act as a helper virus and the dependent virus could again be aphid transmissible, possibly even by a different aphid species. Mixed infections and resulting structural interactions may be considered survival mechanisms for some defective viruses. The dependent viruses from the aphid transmitted complexes almost surely depend upon the mixed infections for their survival and dispersal by the aphid vector. The properties exhibited by the helper dependent viruses are different from many other well characterized plant viruses.

HOEFERT, L. L. Ultrastructure of developing sieve elements in Thlaspi arvense L. I. The immature state. Amer. J. Bot. 66:925-932. 1979.

Descriptions of the structural effects of viruses on host plants require a thorough knowledge of the ultrastructure and development of the tissues of the host plant that are affected. This manuscript and its companion detail the development of sieve elements in Thlaspi arvense, a weed-reservoir host of beet western yellows virus. The immature sieve elements of Thlaspi are somewhat unique in that they contain two morphologically distinct types of P-protein (Phloem protein) - the common tubular-fibrillar type that is present in sieve elements of many plants and one or more granular P-protein bodies that are not so common. The development and fate of the granular P-protein bodies are described.

HOEFERT, L. L. Ultrastructure of developing sieve elements in Thlaspi arvense L. II. Maturation. Amer. J. Bot. 67:194-201. 1979.

This manuscript and its companion describe the development and maturation of sieve elements in the weed Thlaspi arvense, a reservoir host of beet western yellows virus. During maturation, sieve elements lose their nucleus, vacuoles, and a good bit of their cytoplasm, to become practically "empty" tubes through which nutrients and viruses move from one part of the plant to another. The sequence of this maturation process is described and contrasted to similar sequences in other plants.

LEWELLEN, R. T., E. D. WHITNEY, I. O. SKOYEN, and J. S. MCFARLANE. Notice of release of sugarbeet hybrid variety, US H11. USDA-SEA-AR, August 23, 1979.

The Erwinia resistant cultivar US H11 is briefly described in this official USDA-SEA release notice.

ROCHOW, W. F. and JAMES E. DUFFUS. Luteoviruses and yellows diseases. In Comparative Diagnosis of Viral Disease, Vol. IV (Book Chapter). (In press). 1980.

Although luteoviruses did not become a recognized plant virus group until 1975, the diseases they cause have long been observed. Duffus discussed the many causes attributed to yellowing and reddening of crops before the virus nature of many of the problems became known. The virus nature of barley yellow dwarf has been recognized since 1951 and that of beet western yellows since 1960. But actual evidence for the virus nature of luteoviruses was not available until 1964 when relationships were shown in several ways between the presence of a small, isometric particle and the infectivity of barley yellow dwarf virus (BYDV). The recent demonstration of the nature of luteoviruses contrasts not only with the long history of plant diseases they cause, but also with the great economic importance of the viruses.

SCHROTH, M. N., E. D. WHITNEY, S. V. THOMSON, R. T. LEWELLEN, and F. J. HILLS. Bacterial rot of sugarbeet: Problem and solution. Calif. Agric. 33:8-9. 1979.

This article briefly summarizes the sequence of events that lead to the recognition of bacterial soft rot in sugarbeet as an important disease, the identification of the causal organism, Erwinia, contributing factors to disease development, and control with the development of a resistant cultivar, US H11.

YU, M. H. Meiotic chromosome behavior in monoploid sugarbeet. Can. J. Genet. Cytol. 22: (In press). 1980.

The meiotic behavior of a monoploid plant of sugarbeet was studied. At meta-anaphase I univalents, bivalents and trivalents, and secondary associations of up to three chromosomes were observed, with an average of 8.65 I + 0.16 II + 0.01 III per cell or 0.18 chiasmata per cell. Chromosomes migrated to the poles at anaphase I in all possible numerical groupings. Various numbers of laggards, dividing laggards, bridges, and fragments occurred at both divisions. It appears that two or more duplications are present in the genome of this monoploid plant.

BOLTING AND VARIETY TRIALS, SALINAS, CALIFORNIA, 1978-79

Location: USDA Agricultural Research Station

Soil type: Sandy loam (Chualar series).

Previous crops: 1978-79 Sugarbeet test areas, Spence Field:
Block 3 - south, fallow 1975-1977; sugarbeet trials, 1974.
Block 6 - north, fallow 1976-1978; sugarbeet trials, 1975.

Fertilizer used: Preplant: Dolomite (equivalent to 105% $CaCO_3$), as needed, was broadcast at a rate of 1000 lbs/A and disced in about 6 inches deep. All test areas had 310 lbs/A 5:20:10 applied broadcast and chiseled in before listing in August 1978. Prior to seeding, 320-420 lbs/A ammonium sulfate was Bye Hoe incorporated into a 9-inch band on the beds.

Supplemental nitrogen: Two to three applications, as sidedressed ammonium sulfate at rates ranging from 353 to 584 lbs/A.

Total fertilization (lbs/A):

N	P_2O_5	K_2O
290	62	31

Summary: 1978-79 Tests in the Salinas Valley

Test No.	Sowing Date 1978-1979	Thinning Date 1979	Test Entries No.	Reps No.	Plot Row No.	Plot Row Lgth. Ft.	Harvest Date 1979	Test Design
179	11/16	1/22-25	163	2	1	30	- - -	RCB
279	"	"	192	1-2	1	30	- - -	RCB
279-2	"	"	6	8	1	30	- - -	RCB
379	11/15	"	16	4	1	30	- - -	RCB
479	"	"	16	16	1	30	9/11-12	LS
579	1/29	3/12-14	16	8	2	30	9/20	RCB
679	1/29	3/12-14	16	8	2	30	9/12-13	RCB
779	3/5	4/10-12	22	8	2	30	9/24-26	RCB (2x11F)
879	2/7	3/20-21	10	8	2	30	9/26-27	RCB
979	3/5	4/10-12	16	8	2	30	10/10-11	RCB
1079	3/6	"	12	8	2	30	10/9-10	RCB
1179	3/6	"	20	8	2	30	10/2-4	Split-block
1279	2/7	3/20-21	16	4	1	30	- - -	RCB
1379	3/7	4/10-12	8	5	1	30	10/4	Split-plot
1479	2/6	3/20-21	16	8	2	30	9/17-18	RCB
1579	2/6	"	16	8	2	30	9/18-19	RCB
1679	3/7	4/10-12	16	8	2	30	10/1-2	RCB
1779	4/18	5/21-24	2	8	2	63	10/11-12	Split-plot
1879	4/19	"	8	8	1	30	10/15	Split-block
1979	4/19	"	20	8	1	30	10/16-17	Split-block
2079	4/20	"	20	8	1	30	10/22-24	Split-block
2179	4/20	"	14	8	1	30	10/18-22	Split-block
2279	5/31	6/25-27	122	1-4	1	24	- - -	- - -

Inoculation dates (1979): Tests 1879 through 2179: June 6, with BWYV.
Test 2279: August 2, with a suspension of Erwinia bacterium.

Irrigation: By either furrow or sprinkler system as required at 7-14 day intervals except during stand establishment when frequent light sprinkler irrigations were used.

Herbicide application (1979): Pyramin W, at rates of 3 to 4 lbs/A, was sprayed on post plant and watered in with 1/2 to 3/4 inch sprinkler irrigation.

Diseases and insects: Natural virus yellows infection was moderate throughout tests seeded between November 16, 1978 and March 7, 1979. (Tests 179 through 1679, Field 1). Natural infection appeared light in tests seeded between April 18 and May 31, 1979, (Field 2) until late in the season.

Inoculated BWYV tests 1879 through 2179 were sprayed with 1.5 pints/A Meta Systox R on June 8, 1979 for control of BWYV aphid vector.

All tests, inoculated and non-inoculated, were sprayed with 1.5 pints/A Meta Systox R and 1 lb/A Lannate on July 24, 1979 for control of aphid and salt marsh caterpillar.

Powdery mildew was moderately severe in 1979 where it was not controlled and appeared first (early June) in the earliest seeded tests. One or two spray applications of wettable sulfur at rates of 14 to 26 lbs/A, on designated test areas, on June 25, July 30 and August 13, 1979, provided good control.

Downey mildew infection was not a significant disease problem in 1979.

Natural infection of Erwinia soft rot was light and had minimum effect on yield in 1979.

Sugar analysis: Determined from two samples per plot of approximately 10 roots each or 25-40 lbs of roots at the sugar analytical laboratory, U. S. Agricultural Research Station, Salinas, California.

Remarks: Nitrogen application rates were unusually high in 1979 tests because petiole tests in mid-July, as well as visual appearance, showed nitrogen levels well below 1000 ppm, two months prior to beginning harvest.

The assistance of Dr. F. J. Hills and Ms. Patricia Thomas, University of California at Davis, in the analysis of test data is greatfully acknowledged.

BOLTING RESISTANCE EVALUATION TEST, SALINAS, CALIFORNIA, 1978-79
(Test 179)

2 replications
1-row plots, 30 ft. long — Planted: November 16, 1978

Variety	Description	Bolting 7/30 %	Bolting 10/4 %	Powdery Mildew 6/22 Grade[1/]
717H8	US H10	5.6	12.7	4.5
717H17	5551H5 x 417	19.7	23.9	5.0
717H23	5551H21 x 417	21.4	27.1	5.0
717H24	5522-29H21 x 417	12.3	16.4	5.0
E836H24	5522-29H21 x E36	4.1	6.8	5.5
517H29	3536-97H72 x 417	2.8	8.5	5.0
517TH12	546H4 x 117T	9.0	16.4	5.5
517TH17	8551H4 x 117T	11.3	17.5	5.0
517TH29	3536-97H72 x 117T	5.9	7.1	5.0
417H21	536-97H0 x C17	6.6	14.5	6.0
417H28	536-97H3 x C17	9.4	15.6	5.0
617H11	8551H4 x 417	13.0	20.7	5.0
704-13H8	F70-546H3 x 604-13	6.1	7.3	5.5
704-13H17	5551H5 x 604-13	3.8	7.5	6.0
704-13H23	5551H21 x 604-13	6.3	6.3	6.0
704-13H24	5522-29H21 x 604-13	13.2	14.5	6.0
704-15H8	F70-546H3 x 604-15	13.9	22.8	5.0
704-15H17	5551H21 x 604-15	20.0	20.0	5.0
704-15H23	5551H21 x 604-15	8.0	20.0	5.5
704-15H24	5522-29H21 x 604-15	20.5	28.8	6.0
464H2	US H6	13.9	22.2	4.0
464H8	US H7A	15.2	20.3	4.0
F71-17	Inc. F70-17	14.9	17.0	4.5
813	Inc. 413	17.8	28.8	4.5
F77-36	Erwinia sel. 413	22.4	28.6	5.0
517T	Inc. 117T	5.6	7.0	4.5
704-13	Inc. 604-13	17.7	17.7	6.0
804-13ER	Erwinia sel. 604-13	6.9	6.9	7.0
704-15	Inc. 604-15	58.6	58.6	5.0
804-15ER	Erwinia sel. 604-15	18.5	19.8	5.0
704-15CTR	CTRS 604-15	30.2	30.2	5.5
704-23	Inc. 604-23	15.1	17.4	4.5
Y204	Inc. Y104A,B	34.5	44.8	5.5
Y003	Yellows res. line	22.9	28.6	5.0
434	Inc. aamm Sst x 813	8.0	11.4	5.0
834	Inc. 534 (1965)	2.6	7.7	5.0
868	Inc. 868 (1968)	11.4	13.6	5.0
885	Inc. 385	2.5	5.1	4.5
885H0	385H0 x 385	2.5	2.5	4.5
921	Composite of Type O's	25.6	28.2	5.0
364	Pollinator line	16.7	19.4	3.5
864	Inc. 364, 464	26.6	32.8	3.5
F66-569H3	562H0 x 569	53.1	65.4	5.5
F70-546H3	562H0 x 546	18.7	25.3	5.0
F78-546H3	562H0 x 546	9.4	14.1	5.0

1/ 0 = No mildew 9 = Severe mildew

BOLTING RESISTANCE EVALUATION TEST, SALINAS, CALIFORNIA, 1978-79
(Test 179)

2 replications
1-row plots, 30 ft. long — Planted: November 16, 1978

Variety	Description	Bolting 7/30 %	Bolting 10/4 %	Powdery Mildew 6/22 Grade 1/
4554H1	NB1 CMS x NB4	21.7	36.7	4.0
4554H4	3565H0 x 2554(Iso.)	9.2	16.9	4.5
4547H1	502H0 x 547	4.5	19.4	5.0
3536-97H3	562H0 x 536-97	18.8	20.3	6.0
3536-97H72	718H0 x 536-97	11.5	12.6	6.0
F75-536H1	522-29H23 x 536-97	12.8	17.4	6.0
F75-536H4	563H0 x 536-97	14.8	16.4	6.0
7522H4	F67-563H0 x 5522-29	36.8	37.9	5.5
6522-29H1	5522H1 x 5522-29	14.6	14.6	6.5
7522H21	4536-97H0 x 5522-29	21.2	32.9	6.0
5551H5	564H0 x 8551	46.7	55.0	4.5
5551H17	8551H4 x 8551	34.8	39.4	4.5
5551H21	3536-97H0 x 8551	16.7	22.2	5.5
5564H1	(502H0 x 562) x 564	38.1	46.0	5.5
6564H1	(2502H0 x 2563) x 564	49.2	55.6	5.5
Am 7	Amal. variety	100.0	100.0	7.0
UI 8	U and I variety	98.6	100.0	7.0
AC 5	Amer. Crystal hybrid	93.0	93.0	4.5
AC 10	Amer. Crystal hybrid	69.9	76.7	3.5
S72-315 (AC 7)	Amer. Crystal hybrid	97.4	100.0	3.0
AGWD2	G. W. hybrid	75.7	91.4	5.0
Vytomo	Swedish variety	14.5	24.6	4.5
Bush Mono	Bush Johnson variety	18.2	18.2	4.0
FC 3	69-9440	92.6	92.6	4.0
5942	RW880	89.7	89.7	4.5
5941RS	Inc. Yaltushkovsk mm	98.6	98.6	4.0
6952	Inc. Uladovsk mm	93.1	93.1	4.0
6959	Inc. Ramonsk 09	96.8	97.9	4.0
Inbreds				
1502 Sp.	NB1	84.5	85.3	6.0
7502	Inc. S_{19}	46.2	57.7	5.0
8592	Inc. 3592	57.6	63.6	5.5
4547	NB5	1.3	4.0	3.5
8511	Inc. F56-511	100.0	100.0	4.0
6512	NB6 (S_{16})	0.0	0.0	3.0
4554	NB4	22.7	28.8	4.0
7554	Inc. 6554 (F58-554)	12.3	21.5	3.0
6554 S_{14}	Inc. 2554 (Iso.)	25.0	50.0	3.0
8554 S_{14}	Inc. 6554 S_{14}	2.4	4.9	2.5
F66-569	mm inbred	41.0	56.4	5.0

BOLTING RESISTANCE EVALUATION TEST, SALINAS, CALIFORNIA, 1978-79
(Test 179)

2 replications
1-row plots, 30 ft. long — Planted: November 16, 1978

Variety	Description	Bolting 7/30 %	Bolting 10/4 %	Powdery Mildew 6/22 Grade
8569	Inc. F66-569	45.1	52.1	5.0
F70-546	Inc. F63-546	21.4	31.0	4.0
F78-546	Inc. F70-546	15.6	24.4	4.5
8546	Inc. F70-546	3.7	9.9	4.5
6551	Inc. 551	9.1	10.6	4.0
6551H0	551H17 x 551	21.3	28.0	4.0
F67-563	Inc. F63-563	59.4	66.0	5.0
8563	Inc. F67-563	29.8	36.8	5.5
8563aa	2563aa x 5564Aa	31.6	34.2	5.0
F67-563H0	Inc. F63-563	56.9	61.1	5.0
8563H0	F67-563H0 x F67-563	39.3	51.8	5.0
8563 S_{14} Iso.	Inc. S_{14}	0.0	0.0	5.0
8563 S_{14} Sp.	Inc. S_{14}	3.0	7.5	5.0
8563 S_{14} Ore.	Inc. S_{14}	2.7	4.1	5.0
6562	S_{14}(4502 x 4570-49-12)	88.6	93.2	5.0
2562	Inc. S_{11} 4570-49-12	58.3	58.3	4.5
F66-562	mm inbred	59.7	73.6	5.0
8562	Inc. F66-562	45.4	56.5	5.0
F66-562H0	CMS of 562	55.4	60.2	5.0
8562H0	F66-562H0 x F66-562	56.0	69.0	5.0
8562Aa	2563aa x F66-562	36.5	47.3	5.0
5564	Inc. 4564C1	79.2	81.3	5.0
8564	Inc. 5564 & 6564	73.1	79.5	5.0
5564H0	4564H0 x 4564C1	65.5	75.9	5.0
8564H0 Sp.	5564H0 x 5564	65.7	77.6	5.0
8564H0A	6564H2mm x 6564	59.7	66.7	5.5
8564aa Iso.	7104aamm x 5564Aa	25.0	30.0	5.0
8564aa Sp.	4564aa x 5564Aa	38.2	46.1	5.0
8564Aa + aa	Inc. 5564Aa	43.8	54.5	5.0
5564Aa	4564aa x 4564C1	79.2	79.2	5.0
8564Aa	4564aa x 5564	36.4	47.3	5.0
8620bb	Inc. 6620mmC1(CR)	8.5	11.9	5.0
8689	Inc. S_1(502aa x 522-25)mm	20.4	29.6	5.0
4536-97	CTR inbred	13.0	13.0	5.0
4536-97H0	CMS of 536-97	18.5	22.2	5.0
8536	Inc. 536	4.8	9.7	5.5
8536H0	536H0 x 536	4.6	4.6	5.5
8536H3	562H0 x 536	11.6	11.6	5.0
8536H22	522H0 x 536	4.5	4.5	5.5
8536H72	518H0 x 536	17.3	17.3	5.5
3522-25	CTR inbred	46.9	50.0	5.5
5522-29	Inc. 4522-29	56.7	65.0	5.5
5522-29H0	4522-25H0 x 4522-29	50.0	56.3	5.5
6522-29	Inc. 5522-29	27.9	34.4	5.5
6522-29H0	5522-29H0 x 5522-29	11.8	64.7	6.0

BOLTING RESISTANCE EVALUATION TEST, SALINAS, CALIFORNIA, 1978-79
(Test 179)

2 replications
1-row plots, 30 ft. long — Planted: November 16, 1978

Variety	Description	Bolting 7/30 %	Bolting 10/4 %	Powdery Mildew 6/22 Grade
7522 Sp.	Inc. 5522-29	29.2	33.3	6.0
7522H0 Sp.	5522-29H0 x 5522-29	27.5	29.0	5.5
8505H0 Ore.	F67-563H0 x FRS	23.3	26.0	5.0
8505H0 Sp.	F67-563H0 x FRS	20.0	23.1	6.0
8505H22 Sp.	5522-29H0 x FRS	10.9	12.5	5.5
8505H1 Ore.	6564H1 x FRS	14.3	24.3	5.0
8505H2 Ore.	1502H0 x FRS	9.9	20.9	5.5
8505-16 Ore.	FRS(563aa x 502)	44.4	47.6	5.0
8505-16 Sp.	FRS(563aa x 502)	51.4	54.1	5.0
8505-32 Ore.	FRS(563aa x 502)	7.6	7.6	5.0
8505-98 Ore.	FRS(563aa x 502)	36.3	50.0	5.5
8505-98 Sp.	FRS(563aa x 502)	74.4	76.9	5.5
8505-118 Ore.	FRS(563aa x 502)	9.5	17.5	5.0
7563-30	FRS 563	21.5	35.4	5.0
7532	Inc. (502aa x 536-97)	7.9	10.5	6.0
6507	Inc. (563aa x 4502-1)	18.8	28.8	6.0
6510	Inc. (502aa x 565)	21.2	31.8	5.5
8522-10	Inc. 7522-10	0.0	0.0	5.5

TEST 279. BOLTING AND MILDEW EVALUATION TEST, SALINAS, CALIFORNIA, 1979

1 or 2 repetitions
1-row plots, 30 ft. long

Planted: November 16, 1978

Variety	Description	Stand Count	Bolting 7/30	Bolting 10/24	Powdery Mil.[1/] 6/25	Powdery Mil.[1/] 8/7
		No.	%	%	Score	Score
HYBRIDS						
464H8 (US H7A)	F70-546H3 x F66-64	83	7.2	15.7	4.0	5.5
864H8 (US H7A)	" x 364	57	10.5	12.3	4.5	5.5
US H10B	546H3 x C17 (6169)	95	14.7	23.2	6.0	5.5
US H10B	546H3 x C17 (3084)	88	12.5	18.2	6.5	6.0
U836H8 (US H11)	546H3 x C36 (78016)	92	14.1	16.3	6.0	6.0
AC836H8 (US H11)	546H3 x C36 (78050)	95	5.3	7.4	6.0	5.5
E536H8 (US H11)	F70-546H3 x C36	84	20.2	23.8	5.5	6.0
E736H8 (US H11)	F70-546H3 x C36	87	17.2	19.5	6.0	6.0
E836/1H8	F70-546H3 x C36	79	11.4	12.7	6.5	6.0
E836H8	F70-546H3 x E736 (Iso.)	61	9.8	16.4	5.5	5.5
E836H24	5522-29H21 x E736 (Iso.)	87	6.9	8.0	8.0	6.5
E637H8	F70-546H3 x E537	88	9.1	15.9	5.5	5.5
E837H8	F70-546H3 x E737	65	10.8	12.3	5.0	5.5
717H8 (US H10B)	F70-546H3 x C17	93	3.2	8.6	5.0	5.5
717H3	F66-562H0 x C17	85	12.9	17.6	6.0	6.5
717H4	F67-563H0 x C17	84	2.4	7.1	7.5	6.0
717H21	C536H0 x C17	85	3.5	4.7	7.0	6.5
717H72	C718H0B x C17	80	2.5	5.0	5.5	5.5
8717H8	F70-546H3 x 7717	99	8.1	9.1	4.5	5.5
8719H8	F70-546H3 x 6719	95	14.7	14.7	6.5	6.0
Y740H8	F70-546H3 x Y640	86	12.8	14.0	5.5	6.0
Y746H8	F70-546H3 x Y646	88	5.7	8.0	4.5	5.5
Y823H8	F70-546H3 x Y723	83	13.3	19.3	5.0	4.5
Y826H8	F70-546H3 x Y726	87	11.5	20.7	5.5	5.0
Y741H8	F70-546H3 x Y641	81	18.5	34.6	5.5	6.0
Y601H8	F70-546H3 x C01	75	16.0	24.0	6.0	5.5
Y831H8	F70-546H3 x C31E1	71	9.9	9.9	6.0	6.0
Y731H8	F70-546H3 x C31E1	75	6.7	8.0	5.5	6.5
Y631H8	F70-546H3 x C31	79	12.7	20.3	5.0	5.0
Y831H12	7546EH4 x C31E1	61	4.9	9.8	4.5	5.0
Y831H22	6522-29H0 x C31E1	52	5.8	7.7	6.5	7.0
Y731H3	F66-562H0 x C31E1	76	9.2	10.5	6.0	6.5
Y731H4	F67-563H0 x C31E1	71	4.2	5.6	5.5	5.5
Y731H21	C536H0 x C31E1	81	6.2	7.4	6.0	6.0
Y731H29	C536H72 x C31E1	77	2.6	3.9	5.0	5.5
Y731H31	C718H3 x C31E1	73	5.5	13.7	4.0	4.5
Y731H33	3546H72B x C31E1	80	6.3	15.0	4.5	4.5
Y731H72	C718H0 x C31E1	75	6.7	12.0	4.5	5.0
Y831HL10	7730H2 x C31E1	67	6.0	7.5	5.5	5.5
Y831HL12	7731H2 x C31E1	56	10.7	10.7	7.0	6.0

1/ Powdery mildew scored on scale of 0 to 9 (0 = no mildew, 9 = severe mildew). Ratings of 6/25 at peak of initial disease development are probably more reliable than 8/7 ratings.

TEST 279. BOLTING AND MILDEW EVALUATION TEST, SALINAS, CALIFORNIA, 1979 cont.

1 or 2 repetitions
1-row plots, 30 ft. long

Planted: November 16, 1978

Variety	Description	Stand Count	Bolting 7/30	Bolting 10/24	Powdery Mil. 6/25	Powdery Mil. 8/7
		No.	%	%	Score	Score
Y831HL13	7758-1H2 x C31E1	46	4.3	10.9	6.0	5.0
Y831HL15	7758-3H2 x C31E1	36	11.1	19.4	5.0	5.0
Y831HL17	7778H2 x C31E1	51	9.8	11.8	5.5	5.0
Y831HL18	7779H2 x C31E1	46	4.3	8.7	5.5	4.0
Monatunno	Hilleshog	85	1.2	2.4	5.5	4.0
Hh Mono 545	Hilleshog	56	0.0	0.0	3.5	4.5
E840H8	F70-546H3 x E640	45	15.6	24.4	7.0	7.0
Y731HL1	6744H0 x C31E1	49	18.4	22.4	7.0	6.0
Y831HL36	7744aa x C31E1	41	4.9	9.8	6.0	6.0
Y731HL2	6745H0 x C31E1	44	2.3	4.5	7.0	6.0
Y831HL37	7745aa x C31E1	41	7.3	7.3	7.0	5.0
Y731HL3	6755H0B x C31E1	44	6.8	13.6	7.0	5.0
Y831HL38	7755Baa x C31E1	45	20.0	20.0	7.0	4.0
Y731HL4	6796-1H0 x C31E1	42	14.3	19.0	7.0	5.0
Y831HL40	6796-1aa x C31E1	41	19.5	26.8	6.0	5.0
Y731HL5	6796-2H0 x C31E1	42	4.8	9.5	6.0	4.0
Y831HL41	6796-2aa x C31E1	43	11.6	18.6	7.0	4.0
Y831HL6	7789H0 x C31E1	48	4.2	12.5	7.0	6.0
Y831HL39	6789aa x C31E1	40	15.0	17.5	5.0	5.0
Y831HL7	7790H0 x C31E1	36	11.1	13.9	6.0	6.0
Y831HL22	7790aa x C31E1	43	2.3	7.0	6.0	6.0
Y831HL1	7740H0 x C31E1	40	15.0	15.0	6.0	5.0
Y831HL33	7740Baa x C31E1	32	6.3	9.4	6.0	5.0
Y831HL2	7741H0 x C31E1	37	13.5	13.5	6.0	6.0
Y831HL34	7741Baa x C31E1	38	10.5	15.8	5.0	5.0
Y831HL35	7742aa x C31E1	29	41.4	41.4	6.0	6.0
Y831HL42	6792aa x C31E1	29	0.0	0.0	5.0	5.0
Y831HL43	6793aa x C31E1	39	15.4	20.5	7.0	7.0
Y831HL44	6794aa x C31E1	31	3.2	6.5	6.0	7.0
Y831HL45	6795aa x C31E1	19	26.3	42.1	6.0	6.0
OPEN-POLLINATED						
Y823	Inc. Y723	58	29.3	39.7	2.5	4.0
Y826	Inc. Y726	64	29.7	35.9	3.5	4.0
417 (Ore.)	Inc. 813A (C17)	76	11.8	13.2	6.0	5.5
717	Inc. 417 (C17)	70	18.6	20.0	6.0	5.0
E637	Inc. E537	60	11.7	16.7	6.5	5.5
E837	Inc. E737	51	2.0	9.8	6.0	5.0
F77-23	Inc. C23	71	9.9	11.3	6.5	6.0
F77-02	Inc. C02	72	25.0	31.9	7.0	6.5
F70-13	Inc. F66-13 (C13)	42	42.9	47.6	6.5	6.5
F77-36	Inc. C36 (7322)	63	15.9	20.6	6.5	4.5

TEST 279. BOLTING AND MILDEW EVALUATION TEST, SALINAS, CALIFORNIA, 1979 cont.

1 or 2 repetitions
1-row plots, 30 ft. long — Planted: November 16, 1978

Variety	Description	Stand Count	Bolting 7/30	Bolting 10/24	Powdery Mil. 6/25	Powdery Mil. 8/7
		No.	%	%	Score	Score
F78-36	Inc. F77-36 (78087)	78	11.5	14.1	6.5	4.5
F78-36	Inc. F77-36 (78088)	72	6.9	9.7	6.0	5.0
E536 (Sp.)	Inc. E-#'s	62	24.2	37.1	7.0	5.5
E736	Inc. E536 (C36)	71	18.3	32.4	7.0	5.0
E736 (MS)	Inc. E536 (MS)	71	11.3	15.5	6.0	4.5
E836/1	Inc. E536 (Iso.)	70	12.9	17.1	7.0	5.5
E836/2	Inc. E736 (Iso.)	61	6.6	11.5	6.5	5.5
E836/2 (Ore.)	Inc. E736 (Iso.)	72	9.7	12.5	7.5	5.5
E840	Inc. E640	48	22.9	25.0	7.5	6.0
468	Inc. 868 (US 75)	71	22.5	25.4	6.0	6.5
Y830	Inc. Y730	71	29.6	33.8	7.5	7.0
Y839	YRS Y639	78	30.8	30.8	3.5	4.0
Y601	Inc. Y401A (C01)	77	36.4	50.6	5.5	5.0
Y631	Inc. Y331 (C31)	80	20.0	22.5	5.0	4.5
Y631E (C31E1)	ERS Y231	92	7.6	7.6	6.0	4.0
Y731	Inc. Y631E (C31E1)	80	12.5	20.0	5.5	3.5
Y831	Inc. Y631E (C31E1)	84	4.8	6.0	4.5	3.5
Y831E (C31E2)	YRS Y631E	100	5.0	6.0	5.0	3.5
Y841	YRS Y641	101	50.5	61.4	4.5	4.5
Y741	Inc. Y641	95	25.3	33.7	5.0	5.0
Y840	YRS Y640	93	25.8	33.3	4.0	5.0
Y740	Inc. Y640	85	17.6	25.9	5.0	4.5
Y842	YRS Y642	91	17.6	28.6	6.5	6.0
864	Inc. 364, 464 (C64)	78	16.7	29.5	5.0	4.0
Y846	YRS Y646	93	2.2	8.6	3.5	4.0
Y746	Inc. Y646	91	3.3	8.8	4.0	4.0
Y643 (C43)	Inc. 5202	42	21.4	23.8	6.0	5.0
Y644 (C32)	Inc. 4247	40	85.0	85.0	5.0	6.0
Y645	Inc. 3204	43	86.0	86.0	5.0	6.0
Y639	ERS Y439	47	27.7	44.7	5.0	5.0
Y717 (C16)	Inc. Y617 (Iso.)	40	0.0	7.5	5.0	6.0
Y717H0 (C16CMS)	Y617H0 x Y617 (Iso.)	40	2.5	2.5	5.0	5.0
PM-1	435-8-4-1	29	6.9	10.3	5.0	4.0
PM-2	536-34-4-3	21	9.5	9.5	5.0	4.0
PM-3	435-8-1-2	27	0.0	3.7	5.0	3.0
PM-4	435-11-4-1	30	3.3	3.3	5.0	4.0
PM-5	634-18-4-3	34	29.4	41.2	3.0	4.0
PM-6	634-46-4-2	33	3.0	3.0	4.0	4.0
PM-7	536-20-3-2	25	0.0	8.0	4.0	3.0
PM-8	536-31-3-3	36	0.0	0.0	4.0	3.0

TEST 279. BOLTING AND MILDEW EVALUATION TEST, SALINAS, CALIFORNIA, 1979 cont.

1 or 2 repetitions
1-row plots, 30 ft. long

Planted: November 16, 1978

Variety	Description	Stand Count	Bolting 7/30	Bolting 10/24	Powdery Mil. 6/25	Powdery Mil. 8/7
		No.	%	%	Score	Score
SELF-FERTILE, RANDOM-MATING						
7740	T-O-Sel. 6740aa x A	38	31.6	31.6	6.0	6.0
8740	7740Baa x A	84	25.0	27.4	5.5	5.5
8740HO	7740HO x 7740B	92	22.8	30.4	6.0	6.5
7741	T-O-Sel. 6741aa x A	39	38.5	41.0	6.0	6.0
8741	7741Baa x A	73	17.8	17.8	5.0	5.0
8741HO	7741HO x 7741B	80	20.0	32.5	6.0	6.5
7742	YRS 5742 (A,aa)	41	34.1	43.9	6.0	6.0
8742	7742aa x A	79	25.3	27.8	6.0	5.5
8742HO	6742HO x 7742	73	26.0	27.4	6.0	5.5
6744 (C789)	5744aa x A	39	28.2	33.3	7.0	6.0
8744	7744aa x A	65	21.5	23.1	5.5	5.5
8744HO	6744HO x 7744	83	18.1	18.1	5.5	5.0
6745	5745aa x A	45	17.8	24.4	7.0	5.0
8745	7745aa x A	65	10.8	13.8	5.5	4.5
8745HO	6745HO x 7745	57	10.5	14.0	6.0	5.5
8746	ERS 6746 (A,aa)	77	35.1	35.1	5.5	5.5
7747-1,2,3	6219,20,21aa x E-#'s	82	12.2	18.3	7.0	5.0
7748-1,2	6796-1-2aa x E-#'s	76	14.5	18.4	6.5	4.0
7755	6755aa x A	41	34.1	39.0	5.0	4.0
8755	7755Baa x A	75	26.7	30.7	4.0	4.0
8755HO	7755HO x 7755B	71	22.5	29.6	6.5	5.5
8789	ERS 6789 (A,aa)	84	3.6	4.8	6.0	4.5
7789	6789aa x A	39	28.2	33.3	6.0	5.0
7789HO	6744HO x 6789	78	26.9	33.3	6.5	5.5
8790	ERS 6790 (A,aa)	81	19.8	23.5	6.0	6.5
7790	6790aa x A	35	14.3	22.9	7.0	6.0
7790HO	6745HO x 6790	66	25.8	31.8	7.0	6.0
6756	Inc. 5756	35	20.0	22.9	6.0	5.0
6791	4791, 4791Daa x A	35	28.6	34.3	7.0	5.0
8796-1	YRS 6796-1 (A,aa)	66	12.1	16.7	7.0	5.5
7796-1	6796-1aa x A	63	34.9	34.9	6.0	5.0
7796-1HO	6796-1HO x 6796-1	58	29.3	34.5	6.0	6.0
8796-2	YRS 6796-2 (A,aa)	68	14.7	17.6	7.5	5.0
7796-2	6796-2aa x A	67	25.4	34.3	7.5	6.0
7796-2HO	6796-2HO x 6796-2	63	34.9	49.2	7.0	6.5
8792	ERS 6792 (A,aa)	70	0.0	0.0	3.0	4.0
8793	ERS 6793 (A,aa)	75	9.3	10.7	7.5	6.0
8794	ERS 6794 (A,aa)	69	7.2	10.1	6.5	6.0
8795	ERS 6795 (A,aa)	67	25.4	37.3	7.5	6.5
8798	ERS 6798 (A,aa)	23	34.8	39.1	4.0	4.5

TEST 279. BOLTING AND MILDEW EVALUATION TEST, SALINAS, CALIFORNIA, 1979 cont.

1 or 2 repetitions
1-row plots, 30 ft. long

Planted: November 16, 1978

Variety	Description	Stand Count	Bolting 7/30	Bolting 10/24	Powdery Mil. 6/25	Powdery Mil. 8/7
		No.	%	%	Score	Score
SELF-FERTILE LINES AND F_1 HYBRIDS						
6719	ERS 4717	63	27.0	36.5	5.0	3.0
8719	Inc. 6719	47	12.8	19.1	5.0	2.5
8717	Inc. 7717	42	0.0	2.4	4.5	3.0
8790-20C1	ERS 5790-20⊗	73	1.4	2.7	5.5	5.0
8790-34C1	ERS 5790-34⊗	63	1.6	1.6	4.5	5.0
8790-39C1	ERS 5790-39⊗	64	6.3	6.3	4.5	3.5
8790-73C1	ERS 5790-73⊗	61	34.4	42.6	6.0	5.5
8790-75C1	ERS 5790-75⊗	62	62.9	64.5	4.0	5.5
F78-546	Inc. F70-546 (78156)	77	6.5	6.5	5.5	6.0
7546E	ERS F70-546	83	12.0	14.5	5.5	5.5
F66-562	6618	90	47.8	47.8	6.5	8.0
F66-562H0	6349	85	61.2	68.2	6.5	8.0
F67-563	7433	80	46.3	50.0	7.0	8.0
F67-563H0	7432	68	55.9	67.6	7.0	8.0
F74-718	Inc. C718 (4170)	68	39.7	42.6	6.5	6.5
F74-718H0	C718H0 x C718 (4169)	68	33.8	39.7	6.5	7.0
8779 (C779)	Inc. 7779	69	15.9	23.2	2.0	1.5
8779H0 (C779CMS)	7779H0 x 7779	64	7.8	15.6	3.5	2.0
7730	Inc. 6730	40	67.5	67.5	7.0	6.5
7730H2	6730H72 x 6730	80	45.0	62.5	8.0	7.0
7758-1	Inc. 6758-1	69	0.0	4.3	7.0	6.0
7758-1H2	6758-1H72 x 6758-1	78	7.7	7.7	7.5	5.5
7758-3	Inc. 6758-3	66	7.6	9.1	6.5	5.0
7758-3H2	6758-3H72 x 6758-3	70	5.7	11.4	8.0	7.0
F70-546H3	562H0 x F63-546	72	9.7	9.7	6.0	6.0
F78-546H3	562H0 x 546 (78155)	86	5.8	10.5	6.0	6.0
8779H3	F66-562H0 x 7779	65	18.5	23.1	7.0	6.5
7730H3	F66-562H0 x 6730	61	41.0	50.8	8.0	7.5
7758-1H3	F66-562H0 x 6758-1	77	11.7	16.9	7.5	7.0
7758-3H3	F66-562H0 x 6758-3	70	8.6	15.7	6.5	7.0
8779H72	F74-718H0 x 7779	82	4.9	14.6	6.0	3.5
7730H72	3718H0(B) x 6730	58	36.2	44.8	6.0	5.5

TEST 279B. BOLTING EVALUATION OF HYBRID AND POLLINATOR SEED LOTS, SALINAS, CALIFORNIA, 1979

5 replications
1-row plots, 30 ft. long — Planted: November 16, 1978

Variety	Description	Bolting 7/30 %	Bolting 10/4 %
US H10B	546H3 x C17 (3084)	18.5	22.8
US H10B	" x " (6169)	18.7	23.1
E837H8	" x E737 (C17E2)	13.8	18.3
U836H8 (US H11)	" x F77-36 (78016)	5.6	9.2
AC 836H8 (US H11)	" x " (78050)	11.1	13.1
E736H8 (US H11)	" x C36	14.5	17.6
8717H8	" x 7717	14.6	21.5
8719H8	" x 8719	19.1	25.0
Y731H8	" x C31E1	14.4	17.6
417 (Ore.)	Inc. C17	14.2	19.3
E837	Inc. E737 (C17E2)	13.5	16.3
E736 (Sp.)	Inc. C36	21.3	24.3
F77-36	Inc. C36 (7322)	24.0	24.5
F78-36	Inc. F77-36 (78087)	12.4	15.6
F78-36	Inc. F77-36 (78088)	9.0	13.3
E836/1	Inc. C36	16.8	18.7
E836/2 (Ore.)	Inc. E736 (Iso.)	12.7	14.5
E836/2 (Sp.)	Inc. E736 (Iso.)	21.5	22.9

TEST 279C. BOLTING SELECTION PLOTS, 1979

Y839	YRS Y639	28.6	37.3
Y840	YRS Y640	19.3	25.3
Y841	YRS Y641	46.1	58.4
Y846	YRS Y646	5.2	7.3
Y831E (C31E2)	YRS Y631E	5.0	8.0
8719C1	ERS 6719⊗	27.2	32.1
8720C1	YRS 6212⊗	18.0	20.9
8721C1	YRS 6211⊗	13.4	17.2
8722C1	YRS 6209⊗	21.7	27.3

COMBINED ANALYSES OF 1979 TESTS AT
SALINAS AND BRAWLEY, CALIFORNIA

Variety	Description	Acre Yield Sugar Pounds	Beets Tons	Sucrose Percent
Tests 479, 679, 1479, 1579, 1679, and B379				
Y731H8	546H3 x C31E1	10,737	35.27	15.16
US H10B	546H3 x C17	10,731	36.12	14.79
US H11	546H3 x C36 (78050)	10,468	35.99	14.48
Grand Mean		10,646	35.79	14.81
LSD (.05)		NS	NS	0.44
Coefficient of Variation (%)		8.0	7.50	6.70
F value for varieties		1.9 NS	1.1 NS	5.4*
F value for varieties x tests		0.4 NS	0.2 NS	0.5 NS
Tests 679, 1579, and 1679				
Y731H8	546H3 x C31E1	11,039	36.25	15.24
US H10B	546H3 x C17	11,008	37.42	14.72
SSE1	Spreckels' C36 hybrid	10,871	37.03	14.68
US H11	546H3 x C36 (78016)	10,787	37.21	14.47
US H11	546H3 x C36 (78050)	10,645	37.18	14.33
Grand Mean		10,870	37.02	14.69
LSD (.05)		NS	NS	0.58
Coefficient of Variation (%)		8.2	6.50	6.80
F value for varieties		1.6 NS	1.2 NS	3.0*
F value for varieties x tests		0.5 NS	0.5 NS	0.4 NS
Tests 479, 1479, and B379				
Y823H8	546H3 x Y723	10,762	35.92	14.84
8717H8	546H3 x 7717	10,762	35.34	15.05
8719H8	546H3 x 8719	10,671	34.88	15.18
US H10B	546H3 x C17	10,455	34.82	14.86
Y731H8	546H3 x C31E1	10,435	34.30	15.08
E837H8	546H3 x C17E2	10,330	34.46	14.84
US H11	546H3 x C36 (78050)	10,292	34.79	14.64
E736H8	546H3 x C36	9,639	33.07	14.50
Y826H8	546H3 x Y726	9,622	31.99	14.94
Y830H8	546H3 x Y730	9,539	32.74	14.44
Grand Mean		10,251	34.23	14.84
LSD (.05)		499	1.57	NS
Coefficient of Variation (%)		8.7	8.60	7.70
F value for varieties		7.4**	5.0**	1.0 NS
F value for varieties x tests		1.6 NS	2.2 **	0.6

TEST 479. BOLTING AND YIELD EVALUATION OF HYBRIDS, SALINAS, CALIFORNIA, 1978-79

16 x 16 Latin square
1-row plots, 30 ft. long

Planted: November 15, 1978
Harvested: September 11-12, 1979

Variety[1]	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/ 100' Number	Root Rot[2] Percent	Bolting 7/30 Percent	Bolting 9/5 Percent	PM 6/26[3] Rating
8717H8	546H3 x 7717	14,627	44.65	16.47	137	0.0	5.7	7.4	5.3
Y823H8	546H3 x Y723	14,563	45.33	16.14	126	0.9	20.3	25.2	4.8
Y731H8	546H3 x Y631E (C31E1)	14,497	44.22	16.47	136	1.1	3.7	5.9	6.0
Y741H8	546H3 x Y641	14,349	43.87	16.39	135	0.6	15.0	19.7	5.3
8719H8	546H3 x 6719	14,286	43.87	16.38	136	0.0	12.1	14.9	6.2
717H8	546H3 x 417 (C17)	14,073	44.55	15.86	133	3.0	7.7	10.8	6.2
E837H8	546H3 x E737	13,995	43.11	16.33	121	0.2	7.1	10.3	6.8
Y746H8	546H3 x Y646	13,957	43.07	16.26	137	1.0	3.9	6.2	5.8
U836H8	546H3 x F77-36	13,789	43.36	15.98	138	0.2	4.5	6.1	7.5
Y740H8	546H3 x Y640	13,616	43.27	15.78	136	0.6	12.0	14.2	6.3
AC836H8	546H3 x F77-36	13,541	42.53	16.02	141	0.3	7.6	9.7	7.2
464H8	546H3 x F66-64	13,295	41.82	15.93	127	0.5	10.4	12.8	5.0
E736H8	546H3 x E536 (C36)	12,988	40.88	16.04	130	0.5	10.9	12.2	7.0
Y830H8	546H3 x Y730	12,928	40.12	16.18	129	0.8	19.4	22.4	7.0
704-15H8	546H3 x 604-15	12,726	39.93	16.03	137	1.5	15.4	18.4	6.3
Y826H8	546H3 x Y726	12,586	38.72	16.38	123	1.4	20.3	27.1	5.7
Mean		13,738	42.71	16.16	133	0.8	11.0	14.0	6.2
LSD (.05)		599	1.94	NS	7	1.1	3.8	4.1	--
Coefficient of Variation (%)		6	6.53	5.01	7	209.4	49.5	42.1	--
F value		9.8**	7.5**	1.2 NS	6.3**	3.3**	17.7**	21.64**	--

1/ 717H8 = US H10B. US H11 = U836H8, AC836H8, E736H8
2/ % roots with erwinia soft rot detected at harvest.
3/ Powdery mildew controlled with wettable sulfur following this rating.

TEST 679[1]. HYBRID TEST, SALINAS, CALIFORNIA, 1979

16 varieties, 8 replications, RCB
2-row plots, 30 ft. long

Planted: January 29, 1979
Harvested: September 12-13, 1979

Variety[2]	Description	Acre Yield		Sucrose	Beets/ 100'	Root Rot[3]	Bolting
		Sugar Pounds	Beets Tons	Percent	Number	Percent	Percent
Y731H30[4]	3536-94H54 x Y631E (C31E1)	12,124	40.75	14.92	118	3.0	0.4
Y731HL11	6758-3H72 x Y631E	11,892	39.78	14.96	115	1.5	0.0
Y731HL10	6758-1H72 x Y631E	11,697	38.59	15.21	117	2.8	0.0
717H23	5551H21 x 417 (C17)	11,605	39.97	14.59	117	4.5	0.2
Y731H8	F70-546H3 x Y631E	11,589	37.68	15.43	121	1.7	0.0
Y731H33	3546H72B x Y631E	11,517	39.22	14.71	114	0.9	0.0
717H8	F70-546H3 x 417	11,472	38.70	14.86	130	2.7	0.2
717H17	5551H5 x 417	11,461	40.75	14.06	119	2.6	0.3
SSE1	Sprex F77-36 Hybrid	11,294	37.72	15.04	118	0.2	0.0
E736H8	F70-546H3 x E536 (C36)	11,166	38.01	14.74	122	0.0	0.4
717H24	5522-29H21 x 417	11,161	39.05	14.33	120	7.8	0.2
U836H8	546H3 x F77-36 (78016)	10,888	38.65	14.11	122	0.2	0.2
AC836H8	546H3 x F77-36 (78050)	10,860	37.42	14.48	120	0.2	0.2
704-15H8	F70-546H3 x 604-15	10,682	37.17	14.39	118	1.1	1.4
E836H24	5522-29H21 x E736 (Iso.)	10,565	37.81	13.94	119	0.6	0.5
704-15H24	5522-29H21 x 604-15	9,066	33.06	13.74	119	1.8	1.2
Mean		11,190	38.39	14.60	119	2.0	0.3
LSD (.05)		654	1.87	0.93	NS	1.7	0.6
Coefficient of Variation (%)		6	4.9	6.5	8	86.4	186.8
F value		9.3**	7.3**	2.1*	1.1 NS	11.2**	4.3**

1/ A duplicate planting of this test was made in February (Test 1579).
2/ 717H8 = US H10B. US H11 = E736H8, U836H8, and AC836H8.
3/ % roots with erwinia soft rot detected at harvest.
4/ The female parentage of this hybrid is uncertain.

TEST 1579[1]. HYBRID TEST, SALINAS, CALIFORNIA, 1979

16 varieties, 8 replications, RCB
2-row plots, 30 ft. long

Planted: February 6, 1979
Harvested: September 18-19, 1979

Variety[2]	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/ 100' Number	Root Rot[3] Percent	Bolting Percent
Y731H33	3546H72B x Y631E (C31E1)	10,244	37.17	13.82	139	0.3	0.0
Y731H30[4]	3536-94H54 x Y631E	9,745	34.47	14.18	134	2.3	0.2
Y731HL11	6758-3H72 x Y631E	9,721	34.46	14.06	137	1.6	0.1
Y731H8	F70-546H3 x Y631E	9,715	34.03	14.29	127	1.1	0.2
717H17	5551H5 x 417 (C17)	9,684	36.00	13.53	145	3.2	0.2
717H8	F70-546H3 x 417	9,602	34.80	13.84	137	1.4	0.0
E836H24	5522-29H21 x E736 (Iso.)	9,577	35.57	13.44	144	0.2	0.6
Y731HL10	6758-1H72 x Y631E	9,554	33.80	14.13	137	1.7	0.0
AC836H8	546H3 x F77-36 (78050)	9,527	34.74	13.72	145	0.3	0.0
U836H8	546H3 x F77-36 (78016)	9,472	34.81	13.63	144	0.1	0.0
717H24	5522-29H21 x 417	9,321	35.41	13.13	156	3.3	0.0
SSE1	Sprex F77-36 Hybrid	9,271	34.40	13.48	143	0.2	0.0
E736H8	F70-546H3 x E536 (C36)	9,069	34.06	13.29	138	0.5	0.0
717H23	5551H21 x 417	8,807	33.89	12.84	142	2.8	0.0
704-15H8	F70-546H3 x 604-15	8,640	32.35	13.36	138	0.8	0.0
704-15H24	5522-29H21 x 604-15	7,548	29.00	13.01	140	2.3	0.0
Mean		9,343	34.31	13.61	140	1.4	0.1
LSD (.05)		1,030	2.94	NS	11	1.6	0.3
Coefficient of Variation (%)		11	8.60	8.00	8	116.3	355.6
F value		2.8**	2.86**	1.24 NS	2.6**	4.0**	2.7**

1/ Test 1579 is a duplicate of Test 679 planted in January.
2/ 717H8 = US H10B. US H11 = E736H8, U836H8, and AC836H8.
3/ % roots with erwinia soft rot detected at harvest.
4/ The female parentage of this hybrid is uncertain.

TEST 1479. 546H3 X POLLINATORS HYBRID TEST, SALINAS, CALIFORNIA, 1979

16 varieties, 8 replications, RCB
2-row plots, 30 ft. long

Planted: February 6, 1979
Harvested: September 17-18, 1979

Variety[1]	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot[2]	Bolting
		Pounds	Tons	Percent	Number	Percent	Percent
Y831H12	7546EH4 x Y631E (C31E1)	10,036	35.55	14.11	125	1.5	0.1
8719H8	546H3 x 6719	9,926	34.41	14.47	140	0.3	0.1
Y740H8	546H3 x Y640	9,888	35.32	14.01	133	1.4	0.0
8717H8	546H3 x 7717	9,806	34.04	14.41	143	0.0	0.4
Y823H8	546H3 x Y723	9,805	34.48	14.14	134	0.9	0.0
E837H8	546H3 x E737	9,681	35.08	13.85	133	0.9	0.3
US H10B	546H3 x C17 (86169)	9,671	33.97	14.29	142	3.6	0.1
Y731H8	546H3 x Y631E (C31E1)	9,605	33.40	14.44	133	0.8	0.0
Y741H8	546H3 x Y641	9,547	34.43	13.88	133	1.4	0.5
E736H8	546H3 x E536 (C36)	9,405	34.84	13.53	130	0.3	0.0
Y746H8	546H3 x Y646	9,326	34.00	13.69	135	0.3	0.0
464H8	546H3 x F66-64	9,189	33.33	13.82	140	0.4	0.0
Y826H8	546H3 x Y726	9,114	32.89	13.81	134	0.3	0.3
U836H8	546H3 x F77-36 (78016)	9,033	33.37	13.54	140	0.3	0.0
Y830H8	546H3 x Y730	8,987	33.46	13.45	133	1.4	0.6
704-15H8	546H3 x 604-15	8,308	32.00	12.90	131	1.0	0.2
Mean		9,458	34.04	13.90	135	0.9	0.2
LSD (.05)		895	NS	NS	NS	1.2	NS
Coefficient of Variation (%)		10	7.00	8.40	8	126.9	264.3
F value		2.0*	1.20 NS	1.04 NS	1.4 NS	4.4**	1.6 NS

1/ US H11 = U836H8 and E736H8. US H7A = 464H8. 546H3 = C562CMS x C546.

2/ % roots with erwinia soft rot detected at harvest.

TEST 879. EVALUATION OF ADVANCED DISEASE-RESISTANT MONOGERM INBREDS
SALINAS, CALIFORNIA, 1979

10 varieties, 8 replications, RCB
2-row plots, 30 ft. long

Planted: February 7, 1979
Harvested: September 26-27, 1979

Variety[1]	Description[2]	Acre Yield		Sucrose	Beets/ 100'	Root Rot[3]
		Sugar	Beets			
		Pounds	Tons	Percent	Number	Percent
Y731H33	546H72 x Y631E	10,633	37.71	14.12	144	0.4
Y831HL15	758-3H2 x Y631E	10,632	35.84	14.84	116	1.7
Y731H72	C718H0 x Y631E	10,425	37.22	14.03	140	1.5
Y831HL13	758-1H2 x Y631E	10,338	34.74	14.88	129	1.0
Y831HL12	731H2 x Y631E	10,334	34.94	14.81	127	2.1
Y731H8	546H3 x Y631E	10,190	35.58	14.30	137	1.0
Y831HL10	730H2 x Y631E	10,182	35.07	14.56	137	3.4
Y831HL18	779H2 x Y631E	10,004	34.33	14.59	143	3.4
U836H8	546H3 x F77-36 (78016)	9,823	35.39	13.86	142	0.2
Y831HL17	778H2 x Y631E	9,683	32.86	14.76	129	1.5
Mean		10,224	35.37	14.48	134	1.6
LSD (.05)		NS	2.63	NS	12	1.6
Coefficient of Variation (%)		8	7.40	5.50	9	98.9
F value		1.3 NS	2.2*	1.8 NS	4.1**	3.8**

1/ U836H8 = US H11

2/ 546H72 = C718H0 x C546. 546H3 = C562H0 x C546. H2 = 2nd BC of type-O inbred to C718H0. Y631E = C31E1.

3/ % roots with erwinia soft rot detected at harvest.

TEST 1679. EVALUATION OF ADVANCED AND COMMERCIAL HYBRIDS, SALINAS, CALIFORNIA, 1979

16 varieties, 8 replications, RCB
2-row plots, 30 ft. long

Planted: March 6, 1979
Harvested: October 1-2, 1979

Variety[1]	Description	Acre Yield Sugar Pounds	Acre Yield Beet Tons	Sucrose Percent	Beets/ 100' Number	Root Rot[2] Percent	Bolting Percent
1443	Betaseed	12,475	37.78	16.51	128	1.1	0.0
SSE1	Sprex F77-36 Hybrid	12,049	38.99	15.51	143	0.0	0.0
Y731H72	C718H0 x Y631E (C31E1)	11,980	39.42	15.22	131	0.7	0.0
AC836H8	546H3 x F77-36 (78050)	11,973	39.48	15.21	140	0.3	0.0
US H10B	546H3 x C17 (86169)	11,950	38.76	15.45	146	1.5	0.0
Y731H33	546H72 x Y631E (C31E1)	11,853	38.65	15.36	137	0.3	0.0
Y731H8	546H3 x Y631E (C31E1)	11,813	37.03	16.00	135	0.5	0.0
Y741H8	546H3 x Y641	11,769	37.81	15.60	139	0.0	0.2
8719H8	546H3 x 6719	11,762	36.82	15.99	124	0.0	0.2
Y823H8	546H3 x Y723	11,707	37.43	15.69	118	0.0	0.0
MonoHy D2	GW Hybrid (77-115)	11,615	36.06	16.13	129	0.1	0.7
U836H8	546H3 x F77-36 (78016)	11,575	38.06	15.26	136	0.2	0.0
E837H8	546H3 x E737	11,530	37.32	15.46	112	0.3	0.0
Y826H8	546H3 x Y726	11,529	37.30	15.49	113	0.0	0.2
Monatunno	Hilleshog (K19307)	11,484	37.15	15.46	137	1.2	0.0
HH27	Holly Hybrid	10,826	34.11	15.86	145	0.0	0.7
Mean		11,743	37.64	15.64	132	0.4	0.1
LSD (.05)		682	2.28	0.54	11	0.7	0.3
Coefficient of Variation (%)		6	6.10	3.50	9	195.0	270.5
F value		2.1*	2.8**	3.6**	6.8**	3.3**	4.2**

1/ US H11 = AC836H8 and U836H8.

2/ % roots with erwinia soft rot detected at harvest.

TEST 779. COMBINING ABILITY EVALUATION OF SINGLE-CROSS AND 3-WAY HYBRIDS WITH TWO TESTERS, SALINAS, CALIFORNIA, 1979

2 x 11 factorial in RCB, 8 replications
2-row plots, 30 ft. long

Planted: March 5, 1979
Harvested: September 24-26, 1979

Hybrid[1/]	Female CMS x T-O		Sugar Yield/Acre x C17	Sugar Yield/Acre x C31E1	Beet Yield/Acre x C17	Beet Yield/Acre x C31E1	Sucrose x C17	Sucrose x C31E1	Root Rot x C17	Root Rot x C31E1	Beets/ 100'
			Pounds	Pounds	Tons	Tons	%	%	%	%	Number
Check											
H33	C718	C546	11,059	11,178	38.75	38.05	14.29	14.68	3.0	0.5	129
Single-cross hybrids											
H72	C718		11,751	10,922	40.70	37.95	14.46	14.37	4.0	0.8	118
H3	C562		10,958	10,970	36.55	36.50	15.00	15.04	4.0	3.0	104
H54	C706		10,751	10,849	36.18	34.92	14.84	15.54	6.7	0.8	130
H21	C536		10,560	10,436	36.35	35.06	14.54	14.90	4.7	1.9	127
3-way hybrids											
H31	C562	C718	11,525	10,675	38.77	36.45	14.88	14.63	4.0	1.5	125
H82	C706	C718	10,495	10,925	36.73	36.88	14.28	14.82	4.6	1.5	129
H29	C718	C536	11,207	10,905	38.26	36.95	14.64	14.76	3.7	1.8	125
H35	C562	C706	10,552	10,210	35.41	33.29	14.92	15.30	2.9	0.7	124
H28	C562	C536	11,100	11,024	37.15	36.69	14.94	15.00	5.7	3.7	130
H30	C706	C536	10,104	10,885	34.36	37.62	14.70	14.47	7.5	0.3	125
Means[2/]			10,915a	10,816a	37.20a	36.40b	14.68a	14.86a	4.6a	1.5b	124
LSD (.05)			779		2.10		0.64		2.2		5.1
C. V. (%)			7.3		5.8		4.4		72.1		5.8
F value for entries			1.9**		4.7**		1.9**		6.8**		17.3**
F value for F x M			1.5 NS		2.4**		0.9 NS		2.7**		---

[1/] See pages A35-A40, 1978 Report, Sugarbeet Research, "Combining ability evaluation of advanced disease resistant inbreds."

[2/] Means with a letter in common are not significantly different according to the F test.

TEST 979. GCA EVALUATION OF SIMILAR CMS (HO) AND GENETIC MS (aa) LINES, SALINAS, CALIFORNIA, 1979

2 x 7 factorial in RCB, 8 replications
2-row plots, 30 ft. long

Planted: March 5, 1979
Harvested: October 10-11, 1979

Variety	Description[1/]	Acre Yield		Sucrose	Root Rot	Beets/ 100'
		Sugar	Beets			
		Pounds	Tons	%	%	Number
Y731H8	546H3 x Y631E	11,945	38.21	15.63	0.5	127
US H11	546H3 x F77-36(78016)	11,575	38.64	14.99	0.0	129
Y731HL3	6755HO x Y631E	12,301	39.85	15.48	0.8	127
Y831HL38	7755aa x Y631E	12,600	39.52	15.96	0.3	119
Y731HL4	6796-1HO x Y631E	11,824	38.95	15.18	0.8	125
Y831HL40	6796-1aa x Y631E	11,863	38.68	15.35	0.5	123
Y731HL5	6796-2HO x Y631E	11,961	38.89	15.39	0.5	126
Y831HL41	6796-2aa x Y631E	12,120	39.53	15.32	0.4	123
Y731HL1	6744HO x Y631E	12,416	40.84	15.21	0.7	130
Y831HL36	7744aa x Y631E	11,957	37.59	15.93	0.8	115
Y731HL2	6745HO x Y631E	11,840	39.31	15.04	0.7	128
Y831HL37	7745aa x Y631E	12,032	39.32	15.33	0.2	121
Y831HL6	7789HO x Y631E	11,054	37.03	14.89	1.5	110
Y831HL39	6789aa x Y631E	11,664	37.16	15.73	0.0	122
Y831HL7	7790HO x Y631E	11,849	37.73	15.72	1.0	109
Y831HL22	7790aa x Y631E	11,493	36.99	15.52	0.0	121
Grand mean		11,906	38.64	15.42	0.5	122
LSD (.05)		785	NS	0.68	NS	8
C. V. (%)		6.7	6.7	4.5	170.3	6.9
F value for entries		1.7*	1.5NS	1.7*	1.5NS	4.3**
F value for Female x MS-type		0.9NS	1.0NS	1.2NS	1.3NS	---
CMS (HO) hybrid means		11,892	38.94	15.27	0.9	122
aa hybrid means		11,961	38.40	15.59	0.3	121
		NS[2/]	NS	*	**	---

1/Y631E = C31E1. US H11 = U836H8. 7744 and 6744HO = C789 and C789CMS, respectively.
2/According to the F-test.

TEST 1079. PERFORMANCE OF MONOGERM, SELF-FERTILE, RANDOM-MATING POPULATIONS
SALINAS, CALIFORNIA, 1979

12 varieties, 8 replications, RCB
2-row plots, 30 ft. long

Planted: March 6, 1979
Harvested: October 9-10, 1979

Variety	Description	Acre Yield		Sucrose	Beets/ 100'	Root Rot	Soluble Solids	Non Suc. Soluble Solids	Raw Juice Apparent Purity
		Sugar	Beets						
		Pounds	Tons	Percent	Number	Percent	Percent	Percent	
8755	7755Baa x A	11,448	36.72	15.59	131	0.5	18.4	2.8	84.8
F78-36	Inc. F77-36 (78087)	10,646	35.49	15.00	135	0.0	17.8	2.8	84.3
F78-546H3	562H0 x 546 (78155)	10,549	33.30	15.86	127	0.4	18.7	2.8	85.0
7789	6789aa x A	10,530	32.70	16.11	127	0.5	19.2	3.1	83.7
7796-1	6796-1aa x A	10,062	32.81	15.32	123	1.2	18.3	2.9	83.9
8742	7742aa x A	10,061	32.21	15.63	126	0.0	18.8	3.2	83.1
8741	7741Baa x A	9,821	30.24	16.26	126	0.5	19.5	3.2	83.6
8744	7744aa x A	9,805	30.17	16.26	123	0.2	19.5	3.3	83.4
7796-2	6796-2aa x A	9,787	31.71	15.45	129	0.2	18.5	3.0	83.7
8740	7740Baa x A	9,723	30.29	16.06	123	0.4	19.2	3.1	83.8
8745	7745aa x A	9,704	31.05	15.64	120	0.2	18.7	3.1	83.7
7790	6790aa x A	9,660	30.55	15.81	130	0.0	18.7	2.9	84.4
Mean		10,150	32.27	15.75	127	0.3	18.8	3.0	84.0
LSD (.05)		553	1.53	0.65	NS	NS	0.8	0.3	NS
Coefficient of Variation (%)		6	4.80	4.20	8	228.8	4.0	9.9	1.7
F value		7.6**	15.0**	2.8**	1.4 NS	1.6 NS	3.7**	2.4*	1.4 NS

TEST 1179-1[1/]. COMPARISON OF S_1 AND TEST-CROSS EVALUATION AND SELECTION: 790 SYNTHETICS PER SE
SALINAS, CALIFORNIA, 1979

10 varieties, 8 replications, RCB
2-row plots, 30 ft. long

Planted: March 6, 1979
Harvested: October 2-4, 1979

Variety	Description[2/]	Sugar Yield		Beet Yield		Sucrose		Beets/ 100'	Root Rot
		Sugar Lbs/A	Change %[3/]	Beets T/A	Change %[3/]	Sucrose %	Change %[3/]	Number	%
7790D	C1 Syn 1 SY by S_1 eval.	10,400	14.0	33.82	15.1	15.39	-0.9	121	0.5
7790E	C1 Syn 1 SY by TX eval.	9,723	6.5	31.34	6.7	15.55	0.1	121	0.2
7790F	C1 Syn 1 SY by S_1-TX eval.	9,670	6.0	30.62	4.2	15.84	2.0	115	0.8
7790	C1 Syn 2 SY by mass sel.	9,477	3.9	30.44	3.6	15.61	0.5	120	0.0
7790G	C1 Syn 1 %S by S_1 eval.	9,468	3.8	28.47	-3.1	16.66	7.2	122	0.5
7790J	C1 Syn 1 L%S by S_1 eval.	9,405	3.1	32.04	9.1	14.73	-5.2	113	0.6
4790	Source population	9,268	1.6	29.95	1.9	15.48	-0.4	111	0.8
7790C	C0 Syn 1 Inc. thru S_1	9,126	0.0	29.38	0.0	15.54	0.0	121	0.4
7790I	C1 Syn 1 LSY by TX eval.	8,806	-3.5	29.05	-1.1	15.18	-2.3	110	1.5
7790H	C1 Syn 1 LSY by S_1 eval.	8,269	-9.4	26.39	-10.2	15.68	0.9	112	2.3
Mean		9,361		30.15		15.57		117	0.8
LSD (.05)		552	5.9	2.30	7.6	0.66	4.2	7	1.2
Coefficient of Variation (%)		6		7.60		4.30		6	152.6
F value		8.4**		6.3**		4.4**		3.9**	2.7**

1/ See pages A52-A61, 1978 Report, Sugarbeet Research, "Comparison of S_1 and test-cross evaluation after one cycle of selection in sugarbeet."

2/ Syn 1 populations were synthesized from remnant S_1 seed. For TX evaluations, the single-cross C718CMS x C16 was used as the common tester. Selection intensity was approximately 20% for sugar yield (SY) and % sucrose (%S) for both higher and lower (L) performance. An average of 20 self-fertile S_1 plants from each selected family were recombined in isolation plots by harvesting seed only from genetic male-sterile (a_1a_1) segregates.

3/ Synthetic 7790C was used as unselected check to calculate % change.

TEST 1179-2[1/]. COMPARISON OF S_1 AND TEST-CROSS EVALUATION AND SELECTION: 790 SYNTHETICS X Y631E
SALINAS, CALIFORNIA, 1979

10 varieties, 8 replications, RCB
2-row plots, 30 ft. long

Planted: March 6, 1979
Harvested: October 2-4, 1979

Variety	Description[2/]	Sugar Yield		Beet Yield		Sucrose		Beets/ 100'	Root Rot
		Sugar Lbs/A	Change %[3/]	Beets T/A	Change %[3/]	Sucrose %	Change %[3/]	Number	%
Y831HL25	7790Eaa x Y631E	12,176	4.4	37.41	-1.3	16.31	5.9	117	0.7
Y831HL24	7790Daa x Y631E	11,960	2.5	38.19	0.8	15.66	1.7	116	0.4
Y831HL22	7790aa x Y631E	11,729	0.5	37.31	-1.5	15.74	2.2	129	0.2
Y831HL27	7790Gaa x Y631E	11,676	0.1	36.28	-4.2	16.11	4.6	108	1.4
Y831HL21	4790aa x Y631E	11,672	0.1	37.79	-0.3	15.46	0.4	120	0.9
Y831HL23	7790Caa x Y631E	11,665	0.0	37.89	0.0	15.41	0.0	124	0.3
Y831HL29	7790Iaa x Y631E	11,601	-0.5	37.63	-0.7	15.44	0.2	126	0.2
Y831HL26	7790Faa x Y631E	11,589	-0.7	38.19	0.8	15.19	-1.4	106	0.2
Y831HL30	7790Jaa x Y631E	11,221	-3.8	37.86	-0.1	14.81	-3.8	102	2.1
Y831HL28	7790Haa x Y631E	10,722	-8.1	34.34	-9.4	15.63	1.5	123	0.2
Mean[4/]		11,601		37.29		15.58		117	0.7
LSD (.05)		607	5.2	2.12	5.7	0.64	4.1	10	1.3
Coefficient of Variation (%)		5		5.70		4.10		8	196.5
F value		3.4**		2.4*		3.6**		7.1**	2.1*

1/ See pages A52-A61, 1978 Report, Sugarbeet Research, "Comparison of S_1 and test-cross evaluation after one cycle of selection in sugarbeet."

2/ See footnote 2 for test 1179-1. C1 Syn 1 synthetics were grown in an isolation plot with C31E1 as the common pollinator. The synthetics were rogued to a_1a_1 plants from which the hybrid seed was harvested.

3/ The hybrid with the unselected synthetic 7790C was used as the check to calculate % change.

4/ Tests 1179-1 and 1179-2 were grown in a split-plot design. Significant interactions for yield and % sucrose did not occur.

TEST 1879-NONINOCULATED. VIRUS YELLOWS AND PERFORMANCE EVALUATION OF COMMERCIAL HYBRIDS, SALINAS, CALIFORNIA, 1979

Split-block with 8 replications
8 varieties and 2 virus treatments
1-row plots, 30 ft. long

Planted: April 19, 1979
Noninoculated[1/]
Harvested: October 15, 1979

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'[3/]	Root Rot[3/]	Sol. Solids	Non Suc. Sol. Solids	Raw J. Appar. Purity
		Pounds	Tons	Percent	Number	Percent	Percent	Percent	
Y731H33	546H72 x Y631E (C31E1)	8,770	30.20	14.56	133	1.0	16.5	2.0	88.1
HH Mono 545	NB Hilleshog (87386)	8,426	29.63	14.23	123	1.6	16.6	2.4	85.6
1443	Betaseed Hybrid	8,330	27.81	15.00	125	1.5	17.5	2.5	85.8
MonoHy D2	GW Hybrid (77-115)	8,242	27.00	15.26	132	0.4	17.5	2.2	87.2
US H10B	546H3 x C17 (86169)	8,202	28.29	14.55	140	1.1	17.2	2.7	84.6
HH27	Holly Hybrid	8,022	26.70	15.03	139	0.4	17.5	2.5	86.0
U836H8	546H3 x F77-36 (78016)	7,598	26.61	14.28	130	0.0	16.9	2.6	84.8
US H20	(1861 x 2161) x 6322-0	7,281	25.43	14.34	133	0.3	17.0	2.6	84.6
Mean[2/]		8,109	27.71	14.65	132	0.8	17.1	2.4	85.8
LSD (.05)		663	2.24	0.39	NS	NS	0.6	0.4	2.2
Coefficient of Variation (%)		8	8.00	2.70	7.1	140.8	3.5	17.7	2.5
F value		4.1**	4.2**	8.1**	2.0 NS	2.0 NS	3.5**	2.3*	2.8*

1/ The BWYV inoculated performance and % loss data are summarized on the following page.

2/ Means between noninoculated and inoculated treatments were significantly different for sugar and beet yield, % sucrose, soluble solids, and raw juice apparent purity. A significant variety x virus interaction occurred for sugar and beet yield and % sucrose.

3/ Beets/100 ft. and % root rot averaged over both virus treatments.

Note: Frozen brei from US H10B, U836H8, HH27, GWD2, US H20, and Y731H33 was analyzed by Union Sugar for thin juice purity and % sucrose. Means for TJP = 88.5, 87.7, 88.4, 87.9, 87.9, and 88.6, respectively. % sucrose = 14.2, 13.9, 14.6, 14.9, 14.1, and 14.2, respectively. Brei nitrate score for test = 1.3.

TEST 1879-BWYV INOCULATED. VIRUS YELLOWS AND PERFORMANCE EVALUATION OF COMMERCIAL HYBRIDS, SALINAS, CALIFORNIA, 1979

Split-block with 8 replications
8 varieties and 2 virus treatments
1-row plots, 30 ft. long

Planted: April 19, 1979
BWYV Inoculated: June 6, 1979
Harvested: October 15, 1979

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss[4] %	Beet Yield Inoc. T/A	Beet Yield Loss %	Sucrose Inoc. %	Sucrose Loss %	Non Suc. Sol. Solids %	Raw J. Appar. Purity	Yellows Scores[5] 8/4	Yellows Scores[5] 8/18
Y731H33	546H72 x Y631E (C31E1)	7,805	10.1	27.84	6.8	14.04	3.6	2.2	86.6	3.0	2.9
US H10B	546H3 x C17 (86169)	7,001	14.5	25.17	10.8	13.96	3.9	2.4	85.3	3.0	3.0
U836H8	546H3 x F77-36 (78016)	6,757	9.9	25.18	4.6	13.43	5.8	2.5	84.2	3.1	2.9
HH27	Holly Hybrid	6,260	21.4	22.03	17.1	14.23	5.2	2.5	85.1	4.9	4.5
US H20	(1861 x 2161) x 6322-0	5,805	20.0	20.78	18.2	14.01	2.2	2.5	84.9	5.8	5.0
HH Mono 545	NB Hilleshog (87386)	5,788	30.9	22.47	24.2	12.94	9.0	2.4	84.6	6.9	7.3
MonoHy D2	GW Hybrid (77-115)	5,644	30.4	20.02	25.3	14.16	7.1	2.6	84.6	5.4	5.9
1443	Betaseed Hybrid	5,606	32.2	20.04	27.8	14.07	6.1	2.7	83.8	6.6	7.1
Mean		6,333	21.2	22.94	16.8	13.85	5.4	2.5	84.9	4.8	4.8
LSD (.05)		507	7.8	1.68	7.1	0.41	3.1	NS	NS	0.6	0.7
Coefficient of Variation (%)		8	36.7	7.30	42.0	2.90	57.5	19.4	3.2	12.9	14.4
F value		19.7**	11.4**	23.1**	12.2**	9.5**	3.9**	0.9 NS	0.8 NS	53.1**	55.6**

4/ LSD (.05) for differences within varieties for different virus treatments for sugar yield is 519 lbs/A, which approximately represents a 7.2% loss.

5/ Plots were scored for severity of yellows symptoms on a scale of 0 to 9 with 0 = no symptoms.

Note: Frozen brei from US H10B, U836H8, HH27, GWD2, US H20, and Y731H33 was analyzed by Union Sugar for thin juice purity and % sucrose. Means for TJP = 88.3, 86.9, 87.0, 87.0, 87.8, and 88.2, respectively. % sucrose = 13.7, 13.1, 13.8, 13.8, 13.7, and 13.7, respectively. Brei nitrate score for test = 1.4. Statistical analyses have not been completed.

TEST 1979-NONINOCULATED. VIRUS YELLOWS AND PERFORMANCE EVALUATION OF MALES, FEMALES, AND HYBRIDS, SALINAS, CALIFORNIA, 1979

Split-block with 8 replications
20 varieties and 2 virus treatments
1-row plots, 30 ft. long

Planted: April 19, 1979
Noninoculated[1/]
Harvested: October 16-17, 1979

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot
Males		Pounds	Tons	Percent	Number	Percent
417	Inc. C17	7,698	27.73	13.92	127	5.7
Y731	Inc. C31E1	8,487	28.22	15.11	126	0.8
Females						
F78-546H3	C562H0 x C546 (78155)	6,935	24.17	14.38	137	0.0
3546H72	C718H0 x F70-546	7,623	26.09	14.68	131	0.3
Hybrids						
US H10B	546H3 x C17 (86169)	8,231	29.12	14.16	139	2.1
Y731H8	546H3 x C31E1	8,753	29.60	14.78	129	0.0
717H33	3546H72 x C17	8,869	31.04	14.31	128	1.3
Y731H33	3546H72 x C31E1	9,048	30.78	14.73	126	1.0
Other Hybrids						
364H8	546H3 x F66-64	8,245	29.05	14.19	134	0.0
US H11	546H3 x F77-36 (78016)	8,405	29.98	14.04	128	0.0
E837H8	546H3 x E737	8,793	30.16	14.58	131	0.0
8719H8	546H3 x 6719	8,913	30.30	14.72	131	0.0
Y741H8	546H3 x Y641	8,785	30.37	14.44	127	0.3
717H17	5551H5 x C17	8,502	30.78	13.82	135	0.0
717HL3	6755H0 x C17	9,116	32.19	14.16	127	2.7
Y831HL38	7755aa x C31E1	9,343	31.67	14.78	122	0.7
Y831HL36	7744aa x C31E1	8,450	27.90	15.14	127	1.1
Y831HL37	7745aa x C31E1	8,967	30.93	14.51	129	0.3
US H20	(1861 x 2161) x 6322-0	8,000	28.42	14.06	130	0.3
Mono 774	Hilleshog YR Hybrid	7,829	25.99	14.94	126	0.6
Mean[2/]		8,450	29.22	14.47	129	0.9
LSD (.05)		716	2.21	0.64	9	1.9
Coefficient of Variation (%)		9.6	7.70	4.50	7.1	221.3
F value		5.5**	6.9**	2.8**	1.7*	4.0**

1/ The BWYV inoculated performance and % loss data are summarized on the following page.
2/ Means between noninoculated and inoculated treatments were significantly different for sugar and beet yield. A significant variety x virus interaction occurred for sugar and beet yield.

TEST 1979-BWYV INOCULATED. VIRUS YELLOWS AND PERFORMANCE EVALUATION OF MALES, FEMALES, AND HYBRIDS, SALINAS, CALIFORNIA, 1979

Split-block with 8 replications
20 varieties and 2 virus treatments
1-row plots, 30 ft. long

Planted: April 19, 1979
BWYV Inoculated: June 6, 1979
Harvested: October 16-17, 1979

Variety	Description	Sugar Yield		Beet Yield		Sucrose		Beets/	Root	Yellows Scores[4]	
		Inoc.	Loss[3]	Inoc.	Loss	Inoc.	Loss	100'	Rot	8/4	8/24
Males		Lbs/A	%	T/A	%	%	%	Number	%		
417	Inc. C17	7,191	6.6	26.15	6.0	13.85	0.6	129	6.2	1.6	1.3
Y731	Inc. C31E1	8,024	5.6	27.11	3.9	14.86	1.5	117	0.0	3.3	2.6
Females											
F78-546H3	C562H0 x C546 (78155)	5,737	17.3	21.03	13.4	13.74	4.5	127	0.0	6.3	5.3
3546H72	C718H0 x F70-546	6,470	14.5	23.25	10.4	14.00	4.5	139	0.3	4.9	4.0
Hybrids											
US H10B	546H3 x C17 (86169)	7,650	7.1	27.53	5.7	13.94	1.3	133	1.0	3.8	3.3
Y731H8	546H3 x C31E1	7,570	13.1	26.56	10.5	14.34	2.9	133	0.6	4.1	3.1
717H33	3546H72 x C17	8,254	7.1	28.87	7.1	14.28	0.2	128	1.4	3.1	2.3
Y731H33	3546H72 x C31E1	8,045	11.1	27.88	9.3	14.44	1.8	132	0.0	4.0	3.1
Other Hybrids											
364H8	546H3 x F66-64	7,119	12.5	25.78	10.6	13.87	2.2	134	0.0	5.1	4.6
US H11	546H3 x F77-36 (78016)	7,452	11.3	27.53	8.0	13.56	3.3	130	0.0	3.8	3.5
E837H8	546H3 x E737	8,161	6.4	28.82	3.8	14.17	2.7	124	0.0	3.1	2.8
8719H8	546H3 x 6719	8,038	9.3	28.19	6.2	14.24	3.3	135	0.3	2.4	2.1
Y741H8	546H3 x Y641	7,364	15.9	26.22	13.8	14.09	2.2	125	0.0	4.6	4.0
717H17	5551H5 x C17	7,866	7.3	28.93	5.8	13.62	1.4	139	0.3	3.0	2.9
717HL3	6755H0 x C17	8,353	7.6	30.04	6.0	13.91	1.7	129	2.0	3.4	2.6
Y831HL38	7755aa x C31E1	8,389	10.6	28.90	9.0	14.53	1.6	124	0.7	3.9	3.6
Y831HL36	7744aa x C31E1	7,638	8.7	26.21	5.7	14.60	3.4	121	1.0	3.5	2.6
Y831HL37	7745aa x C31E1	7,829	12.6	27.70	10.8	14.23	1.8	124	0.6	3.4	3.1
US H20	(1861 x 2161) x 6322-0	6,166	22.3	22.82	19.5	13.58	3.3	131	0.0	6.4	5.9
Mono 774	Hilleshog YR Hybrid	6,501	16.1	22.38	13.7	14.52	2.6	127	0.0	5.4	6.0
Mean		7,491	11.2	26.60	9.0	14.12	2.3	129	0.7	3.9	[illegible]
LSD (.05)		607	7.6	1.88	7.1	0.60	NS	9	1.8	0.7	0.[illegible]
Coefficient of Variation (%)		8	68.5	7.10	79.7	4.30	160.6	7	259.9	17.8	17.9
F value		12.2**	2.7**	13.5**	2.5**	2.9**	0.8 NS	2.7**	4.5**	23.4**	32.1**

3/ LSD (.05) for difference within varieties for different virus treatments for sugar yield is 502 lbs/A, which represents about a 6.3% loss.

4/ Plots were scored for severity of yellows symptoms on a scale of 0 to 9 with 0 = no symptoms.

TEST 2079-NONINOCULATED. VIRUS YELLOWS AND PERFORMANCE EVALUATION OF MULTIGERM BREEDING LINES
SALINAS, CALIFORNIA, 1979

Split-block with 8 replications
20 varieties and 2 virus treatments
1-row plots, 30 ft. long

Planted: April 20, 1979
Noninoculated[1/]
Harvested: October 22-24, 1979

Variety	Description	Acre Yield		Sucrose	Beets/ 100'	Root Rot
		Sugar	Beets			
		Pounds	Tons	Percent	Number	Percent
Y841	YRS Y641	9,384	31.21	15.04	127	0.3
Y831E	YRS Y631E (C31E2)	9,279	30.42	15.28	124	0.0
Y840	YRS Y640	9,261	32.16	14.40	131	0.0
Y839	YRS Y639	9,082	29.45	15.43	130	0.0
Y741	Inc. Y641	9,071	31.11	14.56	119	0.0
Y731	Inc. Y631E (C31E1)	8,996	30.67	14.72	124	0.6
Y842	YRS Y642	8,935	29.86	14.99	128	0.0
Y846	YRS Y646	8,595	29.28	14.74	128	0.3
E837	Inc. E737 (C17E2)	8,457	29.77	14.28	126	0.3
864	Inc. 364 (C64)	8,416	30.70	13.74	124	0.0
Y826	Inc. Y726	8,182	27.28	14.99	125	0.7
417	Inc. 713A (C17)	7,955	27.73	14.40	127	6.3
Y823	Inc. Y723	7,743	26.51	14.61	104	0.5
F78-36	Inc. F77-36 (78087)	7,657	27.98	13.71	133	0.0
Y003	Inc. Y803	7,614	25.76	14.80	122	0.0
E836/2	Inc. E736 (Lord)	7,496	26.69	14.07	126	0.0
468	Inc. 868 (US 75)	7,159	25.94	13.86	137	0.3
Y830	Inc. Y730	6,837	24.88	13.76	120	2.5
SP6822-0	Lot 0147	6,379	23.42	13.64	128	1.3
704-15	Inc. 604-15	4,287	17.53	12.43	119	0.0
Mean[2/]		8,039	27.92	14.37	125	0.7
LSD (.05)		632	2.43	0.53	11	1.7
Coefficient of Variation (%)		8	8.80	3.70	9	260.9
F value		30.0**	15.4**	14.0**	3.0**	5.8**

1/ The BWYV inoculated performance and % loss data are summarized on the following page.
2/ Means between noninoculated and inoculated treatments were significant for sugar and beet yield. A significant interaction occurred for sugar and beet yield.

TEST 2079-BWVY INOCULATED. VIRUS YELLOWS AND PERFORMANCE EVALUATION OF MULTIGERM BREEDING LINES
SALINAS, CALIFORNIA, 1979

Split-block with 8 replications
20 varieties and 2 virus treatments
1-row plots, 30 ft. long

Planted: April 20, 1979
BWYV Inoculated: June 6, 1979
Harvested: October 22-24, 1979

Variety	Description	Sugar Yield		Beet Yield		Sucrose		Beets/	Root	Yellows Scores[4]	
		Inoc.	Loss[3]	Inoc.	Loss	Inoc.	Loss	100'	Rot	8/4	8/18
		Lbs/A	%	T/A	%	%	%	Number	%		
Y841	YRS Y641	9,029	3.1	30.54	1.5	14.82	1.5	140	0.3	3.0	3.0
Y831E	YRS Y631E (C31E2)	9,007	3.0	29.08	4.5	15.51	-1.6	135	0.3	2.8	2.4
Y839	YRS Y639	8,665	4.4	28.27	3.8	15.33	0.6	133	0.0	3.3	3.1
Y731	Inc. Y631E (C31E1)	8,300	7.4	28.31	7.5	14.73	-0.2	127	0.6	3.4	3.1
Y842	YRS Y642	8,145	8.5	27.28	8.2	14.94	0.2	128	0.0	3.3	3.3
Y741	Inc. Y641	8,137	10.4	28.29	9.2	14.39	1.1	125	0.0	4.4	4.0
Y840	YRS Y640	8,044	13.1	27.82	13.7	14.51	-0.8	127	0.0	3.4	3.0
Y846	YRS Y646	7,927	6.3	27.10	5.9	14.69	0.3	130	0.0	3.0	3.4
E837	Inc. E737 (C17E2)	7,582	10.3	26.91	9.5	14.16	0.8	126	1.7	1.6	1.6
417	Inc. 713A (C17)	7,332	7.7	26.09	5.8	14.11	2.0	135	4.1	1.8	1.6
Y003	Inc. Y803	7,292	4.5	24.97	3.3	14.64	1.0	117	0.7	3.4	2.9
864	Inc. 364 (C64)	7,162	14.4	26.07	14.2	13.74	-0.1	130	0.0	5.4	4.5
Y826	Inc. Y726	7,150	12.8	24.10	12.0	14.85	0.9	130	0.9	4.4	4.1
E836/2	Inc. E736 (Lord)	6,668	10.8	24.23	9.0	13.79	2.0	135	0.0	2.4	2.5
F78-36	Inc. F77-36 (78087)	6,667	12.5	24.71	11.6	13.54	1.1	140	0.0	2.6	2.8
Y823	Inc. Y723	6,309	18.0	22.32	15.2	14.18	2.9	106	1.1	4.9	4.6
Y830	Inc. Y730	6,036	11.7	22.24	10.8	13.65	0.8	125	0.7	4.3	3.9
468	Inc. 868 (US 75)	5,693	20.1	21.23	18.1	13.51	2.5	130	0.3	6.0	5.4
SP6822-0	Lot 0147	4,573	28.3	17.50	25.1	13.06	4.2	136	1.0	7.1	6.0
704-15	Inc. 604-15	3,774	15.4	16.00	12.9	11.97	2.3	126	0.0	4.3	3.7
Mean[2]		7,175	10.7	25.15	9.6	14.21	1.1	129	0.6	3.7	3.4
LSD (.05)		494	8.7	1.92	9.2	0.50	NS	10	1.7	0.7	0.7
Coefficient of Variation (%)		7	82.1	7.70	97.0	3.60	311.6	8	297.8	19.5	20.3
F value		62.1**	4.0**	30.4**	3.1**	21.3**	1.3 NS	4.9**	2.5**	29.0**	20.5**

3/ LSD (.05) for difference within varieties for different virus treatments for sugar yield is 449 lbs/A, which approximately represents a 5.9% loss.

4/ Severity of yellows symptoms with 0 = no symptoms.

TEST 2179-NONINOCULATED. VIRUS YELLOWS AND PERFORMANCE EVALUATION OF SELF-FERTILE, RANDOM-MATING POPULATIONS, SALINAS, CALIFORNIA, 1979

Split-block with 8 replications
14 varieties and 2 virus treatments
1-row plots, 30 ft. long

Planted: April 20, 1979
Noninoculated[1]/
Harvested: October 18 & 22, 1979

Variety	Description	Acre Yield		Sucrose	Beets/ 100'	Root Rot
		Sugar	Beets			
		Pounds	Tons	Percent	Number	Percent
F78-36	Inc. F77-36 (78087)	7,576	27.72	13.67	133	0.0
468	Inc. 868 (US 75)	7,315	26.41	13.81	129	0.8
F78-546H3	562HO x 546 (78155)	7,910	26.98	14.68	136	0.3
3546H72	718HO x F70-546	7,778	26.42	14.75	132	0.3
8755	7755Baa x A	8,704	29.59	14.71	128	0.6
8789	ERS 6789 (A,aa)	8,505	27.88	15.24	127	0.7
8740	7740Baa x A	7,631	24.66	15.51	139	0.3
8744	7744aa x A (YRS C789)	7,485	23.77	15.72	123	2.0
8742	7742aa x A	7,241	24.69	14.63	125	0.3
8745	8745aa x A	7,185	24.24	14.78	121	1.2
8790	ERS 6790 (A,aa)	6,636	21.22	15.59	133	0.3
8741	7741Baa x A	6,581	21.50	15.29	126	0.4
8796-1	YRS 6796-1 (A,aa)	6,366	21.99	14.46	134	0.9
8796-2	YRS 6796-2 (A,aa)	6,050	20.34	14.84	134	0.4
Mean[2]/		7,354	24.81	14.83	130	0.6
LSD (.05)		702	2.30	0.45	10	NS
Coefficient of Variation (%)		10	9.30	3.00	8	223.5
F value		9.4**	11.9**	14.8**	2.2*	1.1 NS

1/ The BWYV inoculated performance and % loss data are summarized on the following page.
2/ Means between noninoculated and inoculated treatments were significantly different.
A significant variety x virus interaction occurred for sugar and beet yield and % sucrose.

TEST 2179-BWYV INOCULATED. VIRUS YELLOWS AND PERFORMANCE EVALUATION OF SELF-FERTILE, RANDOM-MATING POPULATIONS, SALINAS, CALIFORNIA, 1979

Split-block with 8 replications
14 varieties and 2 virus treatments
1-row plots, 30 ft. long

Planted: April 20, 1979
BWYV inoculated: June 6, 1979
Harvested: October 18 & 22, 1979

Variety	Description	Sugar Yield		Beet Yield		Sucrose		Beets/	Root	Yellows Scores[4]	
		Inoc.	Loss[3]	Inoc.	Loss	Inoc.	Loss	100'	Rot	8/4	8/24
		Lbs/A	%	T/A	%	%	%	Number	%		
F78-36	Inc. F77-36 (78087)	7,064	6.8	26.48	4.4	13.32	2.5	144	0.0	2.6	2.8
468	Inc. 868 (US 75)	5,729	21.0	21.61	18.0	13.26	3.9	130	0.6	5.9	5.8
F78-546H3	562H0 x 546 (78155)	6,458	17.9	23.30	13.1	13.87	5.4	144	0.0	6.4	6.1
3546H72	718H0 x F70-546	6,984	9.6	24.35	7.2	14.38	2.5	135	0.4	5.0	4.9
8755	7755Baa x A	7,671	11.9	26.11	11.8	14.69	0.1	137	0.0	5.3	5.3
8789	ERS 6789 (A,aa)	7,863	6.7	26.26	5.0	14.98	1.7	134	0.3	3.9	3.8
8740	7740Baa x A	6,888	8.9	22.82	6.7	15.14	2.3	137	0.6	5.0	5.1
8744	7744aa x A(YRS C789)	6,606	11.3	21.85	7.7	15.10	3.9	132	1.5	4.5	4.6
8742	7742aa x A	5,940	16.8	20.94	14.4	14.19	2.9	134	0.3	5.3	5.6
8745	8745aa x A	6,759	5.0	23.15	4.2	14.62	1.0	124	0.4	4.3	4.0
8790	ERS 6790 (A,aa)	5,969	9.6	20.26	4.3	14.70	5.7	135	0.3	5.0	5.1
8741	7741Baa x A	6,075	6.0	20.25	4.3	15.01	1.8	136	0.3	3.9	3.8
8796-1	YRS 6796-1 (A,aa)	5,931	6.5	20.87	4.7	14.19	1.8	143	2.1	3.8	3.6
8796-2	YRS 6796-2 (A,aa)	5,476	7.4	18.90	5.6	14.49	2.3	143	1.8	3.8	3.8
Mean		6,529	10.4	22.65	8.0	14.43	2.7	136	0.6	4.6	4.6
LSD (.05)		575	8.4	2.03	7.8	0.37	3.0	10	1.2	0.7	0.7
Coefficient of Variation (%)		9	81.0	9.00	98.6	2.60	110.6	7	203.6	14.2	14.8
F value		12.4**	2.7**	11.3**	2.7**	20.9**	2.2*	2.5**	2.4**	18.1**	17.0**

3/ LSD (.05) for differences within varieties for different virus treatments for sugar yield is 469 lbs/A, which approximately represents a 6.7% loss.

4/ Plots were scored for severity of yellows symptoms on a scale of 0 to 9 with 0 = no symptoms.

TEST 1779[1/]. PERFORMANCE OF US H11 VS. MONO-HY D2, SALINAS, CALIFORNIA, 1979

2 varieties, 16 replications, RCB
2-row plots, 63 ft. long

Planted: April 18, 1979
Harvested: October 11-12, 1979

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beets/ 100' Number	Root Rot[2/] Percent	Bolting Percent	Soluble Solids Percent	Non Suc. Soluble Solids Percent	Raw Juice Apparent Purity
Mono-Hy D2	GW Hybrid 77-115	8,776	27.16	16.18	127	0.5	0.3	19.3	3.1	84.1
US H11	546H3 x F77-36(78016)	8,234	27.42	15.05	133	0.0	0.0	18.1	3.0	83.2
Mean		8,505	27.29	15.61	130	0.3	0.2	18.7	3.1	83.7
LSD (.05)		250	NS	0.32	3	0.3	0.3	0.3	NS	NS
Coefficient of Variation (%)		4	2.40	2.70	3	155.7	232.3	2.3	12.6	2.3
F value		21.3**	1.3 NS	57.3**	18.0**	13.2**	5.9*	60.3**	0.1 NS	1.5 NS

1/ This test was designed to compare the effects of rust infection on moderately resistant US H11 and moderately susceptible D2. However, because of the lack of a natural rust epidemic, the protective fungicides were not used on the control plots and the test was harvested and analyzed as a RCB with 2 entries and 16 replications.

2/ % roots with erwinia soft rot detected at harvest.

VARIETY TRIALS, BRAWLEY, CALIFORNIA, 1978-79

Location: USDA-SEA, Imperial Valley Conservation Research Center

Soil type: Holtville silty clay loam

Previous crops: 1978, fallow or small cereal nurseries; 1977, fallow or sugarbeet tests.

Fertilization: Preplant: 720 lbs of 16:20:0 and 880 lbs of 46:0:0 on 3.5 acres broadcast and disced before listing beds.
Sidedress: 100 lbs/A 46:0:0
Total units/acre: N(195):P_2O_5(41):K_2O(0).

Summary: 1978-79 Tests, Brawley, California

Test No.	Sowing Date 1978*	No. Entries per Test	No. Reps.	No. Rows per Plot**	Plot Row Length Ft.	1979 Harvest Date	Test Design
B179	9/14	10	10	1	40	5/15	LS
B279	9/14	10	10	1	40	5/16	LS
B379	9/14	10	10	2	40	5/16-17	LS
B479	9/14	10	10	1	40	5/18	LS
B579	9/14	16	16	1	24	5/18-19	LS
B679	9/14	80	2	1	24	Observation test	
B779	9/13	64	2	1	24	"	"
B879	9/13	10	16	1	24	Late Season Rot test	

*Watered 9/14-16/78 by sprinkler. **Rows 32" wide.

Irrigations: Sprinkled as needed to establish stand, then once following thinning. Then furrow irrigated on 10/12, 11/28/78, 2/2, 3/21, 4/9, and 4/23/79.

Thinned: 9/28-29; 10/2-3/79.

Diseases and insects: No insect control needed. Sulfur dust applied 2/16 and 3/9/79 for powdery mildew control. Herbicides were not used. Virus yellows, probably BWYV, was evident in susceptible hybrids. Effects of yellows were probably light to moderate. Bolting was greater than usual but few plants had advanced to seed production stage and effects on yield were probably minimal. Incidence of root rot in yield tests was extremely low. At harvest, a relatively high mite infestation was present.

Harvest and sugar analysis: Plots were dug with Holly's spike-wheel lifter. Roots from total plot were weighed and two sugar samples removed. Sugar, nitrates, and tare analyses were by Holly Sugar. Root and sugar yields were adjusted for dirt and crown tare. Brei nitrate ratings were made where values of 1, 2, ..., 9 represent 0 to >250 ppm NO_3-N.

Remarks: Stands were consistently excellent. Test reliability should be good despite a severe fertility gradient diagonally across the field. Fertility gradient was partially due to crop history and to an attempt to level the field to a zero grade. Leveling operations had apparently compacted field and many roots were severely sprangled with shallow root penetration.

We wish to acknowledge J. Robertson and C. Brown, I. V. Conservation Research Center, for plot supervision and Patricia Thomas, Davis, CA, for data processing.

TEST B179. IMPERIAL VALLEY TOPCROSS EVALUATION OF FEMALES, 1978-79

10 varieties, 10 replications, Latin square
1-row plots, 40 ft. long, 32" rows

Planted: September 14, 1978
Harvested: May 15, 1979

Variety	Description[1]	Acre Yield[2] Sugar Pounds	Acre Yield[2] Beets Tons	Sucrose Percent	Bolters Percent	Beets/ 100' Number	Clean Beets Percent	Nitrate Nitrogen Rating[3]
Y731H8	546H3 x Y631E	7,415	31.31	11.84	2.2	137	93.1	5.7
Y731H21	4536-97H0 x Y631E	7,317	31.10	11.75	1.7	133	93.1	6.0
Y823HL18	7779H2 x Y723	7,302	32.32	11.29	16.3	122	92.5	5.3
Y831HL13	7758-1H2 x Y631E	7,241	29.27	12.37	0.2	127	92.3	5.6
Monatunno	Hilleshog's K19307	7,210	31.38	11.49	2.2	135	91.3	5.9
Y831HL10	7730H2 x Y631E	7,152	31.32	11.44	12.5	131	90.3	6.0
Y831HL15	7758-3H2 x Y631E	7,056	30.53	11.55	6.7	118	93.1	5.5
Y831HL12	7731H2 x Y631E	6,794	28.52	11.94	4.2	96	94.9	5.7
Y831HL17	7778H2 x Y631E	6,516	28.38	11.48	6.1	117	91.4	5.6
Y831HL18	7779H2 x Y631E	6,453	27.25	11.85	8.4	117	90.7	5.3
Mean		7,045	30.14	11.70	6.1	123	92.3	5.6
LSD (.05)		409	1.77	0.40	3.4	9.1	1.6	0.4
C. V. (%)		6.5	6.7	3.8	63.4	8.3	2.0	8.9
F value		5.5**	6.9**	5.1**	18.0**	14.4**	5.6**	2.6 NS

1/ Y631E = C31E1. 546H3 = 562CMS x 546. 4536-97H0 = C536CMS. H2 = 2nd backcross of type-O line to CMS source (C718CMS).

2/ Yields adjusted to clean weight basis.

3/ Brei NO_3-N by Orion probe. Ratings of 1, 2, ..., 9 correspond to NO_3-N values of 0 to >250 ppm.

TEST B279. IMPERIAL VALLEY HYBRID TEST, 1978-79

10 varieties, 10 replications, Latin square
1-row plots, 40 ft. long, 32" rows

Planted: September 14, 1978
Harvested: May 16, 1979

Variety	Description[1]	Acre Yield[2] Sugar Pounds	Acre Yield[2] Beets Tons	Sucrose Percent	Bolters Percent	Beets/ 100' Number	Clean Beets Percent	Nitrate Nitrogen Rating[3]
Y731H33	546H72 x Y631E	7,121	30.09	11.83	2.5	137	93.9	4.8
Y731H8	546H3 x Y631E	6,837	28.71	11.92	1.6	138	94.5	4.7
717H17	551H5 x 417	6,461	29.99	10.76	2.2	137	93.0	5.3
717H24	522H21 x 417	6,238	28.67	10.86	3.3	135	92.8	5.4
717H8	546H3 x 417	6,179	28.38	10.88	4.0	136	92.7	5.1
704-15H8	546H3 x 604-15	6,139	27.19	11.27	2.8	142	94.9	5.1
E736H8	546H3 x E536	6,127	28.72	10.66	6.8	141	92.8	5.3
717H23	551H21 x 417	6,091	28.58	10.64	4.0	139	91.4	5.5
704-15H24	522H21 x 604-15	5,875	26.08	11.25	0.6	135	94.1	5.3
E836H24	522H21 x E736(I)	5,675	27.43	10.34	4.2	133	92.9	5.5
Mean		6,274	28.39	11.04	3.2	137	93.3	5.2
LSD (.05)		417	1.51	0.38	2.0	NS	1.2	0.3
C. V. (%)		7.5	6.0	3.8	71.1	5.8	1.4	6.2
F value		8.5**	5.2**	15.1**	5.7**	1.1 NS	6.3**	7.5**

1/ Y631E = C31E1. 417 = C17. E536 = C36. 546H72 = 718CMS x 546. 546H3 = 562CMS x 546. 551H5 = 564CMS x 551. 522H21 = 536CMS x 522.

2/ Yields adjusted to clean weight basis.

3/ Brei NO_3-N.

TEST B379. IMPERIAL VALLEY 546H3 X POLLINATOR HYBRID TEST, 1978-79

10 varieties, 10 replications, Latin square
2-row plots, 40 ft. long, 32" rows

Planted: September 14, 1978
Harvested: May 16-17, 1979

Variety	Description	Acre Yield[1/] Sugar Pounds	Acre Yield[1/] Beets Tons	Sucrose Percent	Bolters Percent	Beets/ 100' Number	Clean Beets Percent	Nitrate Nitrogen Rating[2/]
Y823H8	546H3 x Y723	7,916	28.27	14.10	13.6	130	96.9	2.7
8719H8	546H3 x 6719	7,869	27.88	14.16	11.4	137	95.5	2.3
8717H8	546H3 x 7717	7,824	28.04	14.00	2.8	139	95.9	2.5
E837H8	546H3 x E737	7,765	27.60	14.06	7.2	128	94.6	2.4
Y731H8	546H3 x Y631E (C31E1)	7,747	27.62	14.05	3.6	136	96.6	2.7
US H10B	546H3 x C17 (6169)	7,642	27.80	13.76	7.8	137	94.1	2.6
U836H8	546H3 x F77-36	7,636	28.26	13.55	9.3	136	94.9	2.8
Y826H8	546H3 x Y726	7,354	26.15	14.06	9.0	132	95.9	2.7
E736H8	546H3 x E536 (C36)	7,185	27.50	13.16	8.2	137	94.9	2.8
Y830H8	546H3 x Y730	7,100	26.04	13.67	12.3	133	95.8	3.0
Mean		7,604	27.52	13.86	8.5	134	95.5	2.6
LSD (.05)		393	0.93	0.59	2.6	5.4	1.1	NS
C. V. (%)		5.8	3.8	4.8	34.4	4.5	1.3	24.5
F value		4.3**	5.7**	2.3*	14.0**	3.4**	5.2**	1.2 NS

1/ Yields adjusted to clean weight basis.

2/ Brei NO_3-N by Orion probe. Ratings of 1, 2, ..., 9 correspond to NO_3-N values of 0 to >250 ppm and to diphenylamine spot test ratings of 1 through 5.

TEST B479. IMPERIAL VALLEY GCA EVALUATION OF C1 SYN-1 POPULATIONS, 1978-79

10 varieties, 10 replications, Latin square
1-row plots, 40 ft. long, 32" rows

Planted: September 14, 1978
Harvested: May 18, 1979

Variety	Description[1]	Acre Yield[2] Sugar	Acre Yield[2] Beets	Sucrose	Bolters	Beets/ 100'	Clean Beets	Nitrate Nitrogen
		Pounds	Tons	Percent	Percent	Number	Percent	Rating[3]
Y731H8	546H3 x Y631E	7,634a	26.20a	14.60a	3.3	137	97.0	3.6
Y831HL21	4790(aa) x Y631E	7,100b	25.04ab	14.13abcd	8.2	133	97.2	3.6
Y831HL22	7790(aa) x Y631E	7,038b	25.04ab	14.02bcd	11.9	134	96.9	3.7
Y831HL25	7790E(aa) x Y631E	7,010b	24.02b	14.59a	17.5	124	96.7	3.7
Y831HL27	7790G(aa) x Y631E	6,983b	24.17b	14.45ab	18.2	117	97.1	3.4
Y831HL26	7790F(aa) x Y631E	6,941bc	25.05ab	13.88cd	18.9	124	97.4	3.4
Y831HL29	7790I(aa) x Y631E	6,908bc	24.70b	13.95cd	10.3	132	97.1	3.6
Y831HL23	7790C(aa) x Y631E	6,830bc	24.58b	13.88cd	23.9	130	96.9	3.6
Y831HL24	7790D(aa) x Y631E	6,828bc	25.03ab	13.64d	21.1	126	97.0	3.7
Y831HL28	7790H(aa) x Y631E	6,492c	22.69c	14.31abc	10.3	130	97.0	3.4
Mean		6,977	24.65	14.15	14.4	129	97.0	3.6
LSD (.05)		410	1.29	0.44	5.0	9.0	NS	NS
C. V. (%)		6.6	5.9	3.5	39.4	7.8	0.9	14.8
F value		3.9**	4.0**	4.4**	13.2**	3.4	0.5 NS	0.6 NS

1/ Stecklings of each population were rogued to genetic male steriles (aa) and outcrossed to Y631E. 4790 = original source population. 7790 = C1 syn 2 by mass selection. Letters C, D, E, F, G, H, and I refer to C1 syn 1 populations that were derived from recombined 4790 S_1 lines: C = unselected check; D = sugar yield (SY) sel. by S_1 evaluation; E= SY sel. by TX evaluation; F = SY selection by combined S_1-TX evaluation; G = % sugar sel. by S_1 evaluation; H = low SY sel. by S_1 evaluation; and I = low SY sel. by TX evaluation.

2/ Yields adjusted to clean weight basis.

3/ Brei NO_3-N.

TEST B579. IMPERIAL VALLEY EVALUATION OF SIMILAR CMS (HO) AND GENETIC MS (aa) HYBRIDS, 1978-79

16 varieties with 16 reps., Latin square
1-row plots, 24 + 3 ft. long, 32" beds

Planted: September 14, 1978
Harvested: May 18-19, 1979

Variety	Description	Acre Yield[1/] Sugar Pounds	Acre Yield[1/] Beets Tons	Sucrose Percent	Bolting Percent	Beets/ 100' Number	Clean Beets Percent	Nitrate Nitrogen Rating
Y731H8	546H3 x Y631E	8,284	27.55	15.04	3.6	144	96.9	2.8
US H10B	546H3 x C17 (6169)	8,113	28.38	14.31	10.2	141	96.3	2.8
Y731HL3	6755HO x Y631E	8,703	29.04	15.00	15.6	143	97.2	2.8
Y831HL38	7755aa x Y631E	8,356	28.03	14.92	23.1	143	96.9	2.9
Y731HL4	6796-1HO x Y631E	8,223	27.59	14.91	11.0	140	97.1	3.4
Y831HL40	6796-1aa x Y631E	8,366	28.61	14.63	16.0	138	96.7	2.4
Y731HL5	6796-2HO x Y631E	7,729	26.08	14.85	15.6	126	96.6	2.5
Y831HL41	6796-2aa x Y631E	8,066	27.55	14.65	13.0	136	96.5	2.2
Y731HL1	C789HO x Y631E	8,092	28.07	14.38	12.4	142	97.2	2.6
Y831HL36	C789aa x Y631E	7,673	25.04	15.35	13.3	140	96.4	2.5
Y731HL2	6745HO x Y631E	7,960	26.60	14.98	9.1	142	96.3	2.8
Y831HL37	7745aa x Y631E	7,922	27.29	14.53	11.8	139	96.8	2.5
Y831HL6	7789HO x Y631E	7,901	26.92	14.75	25.6	141	97.1	3.1
Y831HL39	6789aa x Y631E	7,289	25.09	14.58	18.4	145	95.6	2.8
Y831HL7	7790HO x Y631E	7,566	25.57	14.81	13.4	143	95.8	2.2
Y831HL22	7790aa x Y631E	8,112	26.90	15.09	13.1	142	96.4	2.6
Grand mean		8,022	27.14	14.80	14.1	140	96.6	2.7
LSD (.05)		417	1.22	0.41	4.7	6.0	NS	NS
C. V. (%)		7.5	6.5	4.0	48.1	6.1	1.6	41.1
F value		5.4**	7.7**	3.5**	9.6**	4.4**	1.6 NS	1.3 NS
CMS (HO) hybrid mean		8,025	27.12	14.81	14.7	--	96.8	2.8
aa hybrid mean		7,969	26.93	14.82	15.2	--	96.5	2.6
		NS[2/]	NS	NS	NS		NS	NS

1/ Yields adjusted to clean weight basis.
2/ Hybrid type means are NS according to F-test.

VARIETY TEST, IMPERIAL VALLEY, CALIFORNIA, 1979
By Holly Sugar Corporation (11971)

8 replications, 1-row plots, RCB
19 ft. long, 30-inch rows

Planted: August 28, 1978
Harvested: June 8, 1979

Variety	Description	Ext. Sugar/A Pounds	Ext. Sugar/T Pounds	Gross Sugar/A Pounds	Beets/A Tons	Sucrose Percent	Beets/ 100' Number	Bolting Percent
E536H33	(718H0 x 546) x C36	11,334	249.3	14,507	45.5	16.04	133	11.4
E736H8	546H3 x C36	11,294	244.4	14,666	46.2	15.87	150	8.8
Y731H8	546H3 x C31E1	11,030	268.7	13,731	41.0	16.73	145	3.0
E506H31	(562H0 x 718) x E406	10,893	245.4	14,122	44.4	15.90	146	14.0
Y731HL4	6796-1H0 x C31E1	10,721	255.0	13,661	42.0	16.25	141	11.2
Y746H8	546H3 x Y646	10,690	262.4	13,083	39.0	16.51	143	2.3
US H10B	546H3 x C17	10,303	243.2	13,406	42.4	15.81	159	7.9
Y741H8	546H3 x Y641	10,087	248.1	13,010	40.7	16.00	147	10.8
717HL1	C789H0 x C17	10,079	249.5	12,972	40.4	16.05	142	25.0
Y740H8	546H3 x Y640	9,997	253.7	12,769	39.4	16.20	143	7.4
E506H8	546H3 x E406	9,801	237.3	12,884	41.3	15.60	142	8.3
Y731HL1	C789H0 x C31E1	9,772	248.5	12,602	39.4	16.01	145	13.6
Grand Mean		10,476	250.5	13,458	41.9	16.08	145	10.4
LSD (.05)		852	9.8	1,058	3.6	0.35	--	--
C. V. (%)		8	3.9	8	8.6	2.19	--	--
Standard Error of the Mean		303	3.4	376	1.3	0.12	--	--
Missing Data		25	15.0	25	11.0	15.00	--	--
F value		3.44**	6.28**	3.48**	3.40**	6.16**	--	--

DATA ON USDA VARIETIES TESTED IN CALIFORNIA BY SPRECKELS SUGAR

1979

TEST AREAS:		Dixon			Mendota		
Variety	Description	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar
USH9B1	546H4 x C413	5.774	38.9	14.8	5.099	30.64	16.6
Y731H8	546H3 x Y631E				5.358	31.33	17.1
E736H8	" x C36	5.703	38.4	14.8			
E702H8	" x C02	5.592	38.0	14.7			
Y731H31	718H3 x Y631E	5.301	35.2	15.0			
Y740H8	546H3 x Y640	5.406	35.9	15.0			
Y741H8	" x Y641	5.640	38.3	14.8	4.978	29.20	17.1
GENERAL MEAN OF TEST		5.652	37.5	15.1	4.946	29.15	17.0
LSD @ P = .05		NS	NS	.4	NS	NS	NS
LSD @ P = .01		NS	NS	.6	NS	NS	NS
S E of Mean		0.178	1.200	0.154	0.207	1.18	0.303
S E in % of Mean		3.15	3.20	1.02	4.18	4.05	1.78
No. Varieties in Test			12			16	
Planting Date			May 10, 1978			April 12, 1979	
Harvest Date			May 8, 1979			October 15, 1979	

VARIETY TEST, NYSSA, OREGON, 1979
By Amalgamated Sugar Company

7 x 7 balanced Lattice

Planted: April 2, 1979
Harvested: October 29, 1979

Variety	Description	Acre Yield E.R.S.1/ Pounds	Acre Yield Roots Tons	Sucrose Percent	Conductivity	Beets/ 100' Number
HH22		7,884	33.87	13.99	941	97
Y731H8	(562 x 546) x C31E1	7,476	31.52	14.47	1027	72
Y740H8	" " x Y640	7,301	31.48	14.12	1037	92
Y741H8	" " x Y641	7,158	30.35	14.31	998	92
Y731H29	(718 x 536) x C31E1	7,809	34.17	14.12	1091	87
Y740H29	" " x Y640	6,952	29.76	14.15	983	79
Y741H29	" " x Y641	6,912	29.56	14.41	1100	76
Test Average		7,666	31.12	14.78	943	92
LSD (.05)		556	2.03	0.36	63	7
LSD (.01)		714	2.62	0.46	82	9
C. V. (%)		11.4	9.6	3.9	10.1	11.2

1/ E.R.S. = Estimated Recoverable Sugar based on the conductivity measurement.

VARIETY TESTS, 1979
By Betaseed, Inc., Kimberly, Idaho

12 varieties x 6 replications, RCB
2-row plots, 30 ft. long

Planted: April, 1979
Harvested: October, 1979

Variety[1/]	Acre Yield: Gross Sugar Pounds	Acre Yield: Rec. Sugar Pounds	Beets Tons	Sucrose Percent	Rec. Sucrose Percent	Qual. Index
Test 88, Nampa, Idaho						
HH22	12,914	11,595	40.64	15.92	14.25	89.5
Y731H8	13,738	12,327	41.06	16.68	14.90	89.2
Y731H29	13,601	11,839	42.33	16.08	14.09	87.6
Y741H8	14,150	12,571	43.18	16.46	14.61	88.8
Y741H29	13,738	11,961	43.18	15.92	13.92	87.4
Y740H8	13,188	11,717	41.06	16.04	14.20	88.6
Y740H29	13,326	11,717	42.75	15.66	13.74	87.7
Average of test	13,738	12,205	42.33	16.23	14.42	88.8
LSD (.05)	812	723	2.67	0.41	0.49	0.9
C.V. (%)			5.4	2.3		
Test 89, Kimberly, Idaho						
HH22	11,116	9,789	35.56	17.06	15.06	88.2
Y731H8	11,589	10,098	34.31	16.89	14.74	87.3
Y731H29	12,062	10,304	35.71	16.84	14.47	85.9
Y741H8	12,062	10,304	36.06	16.62	14.30	86.0
Y741H29	11,589	9,892	35.01	16.61	14.24	85.8
Y740H8	11,707	10,201	35.36	16.61	14.43	86.9
Y740H29	11,470	9,789	34.66	16.50	14.17	85.8
Average of test	11,825	10,304	35.01	16.91	14.74	87.1
LSD (.05)	767	696	2.45	0.53	0.64	1.4
C.V. (%)			6.2	2.8		
Test 90, Minidoka, Idaho						
HH22	10,691	9,201	32.60	16.41	14.18	86.3
Y731H8	10,931	9,392	31.94	17.08	14.76	86.4
Y731H29	11,136	9,488	33.94	16.35	13.92	85.1
Y741H8	11,136	9,584	32.94	16.90	14.50	85.8
Y741H29	11,025	9,392	33.27	16.63	14.21	85.4
Y740H8	11,136	9,488	33.94	16.38	14.00	85.4
Y740H29	10,802	9,201	33.60	16.19	13.78	85.0
Average of test	11,136	9,584	33.27	16.73	14.40	86.0
LSD (.05)	838	749	2.45	0.41	0.47	0.8
C.V. (%)			6.2	2.2		

1/ H8 = C562CMS x C546. H29 = C718CMS x C536. Y731 = C31E1.

COMBINED VARIETY TESTS, IDAHO, 1979
By Betaseed, Inc. (Tests 88,89,90)

2-row plots, 30 ft. long

Planted: April, 1979
Harvested: October, 1979

Variety	Acre Yield				
	Gross Sugar Pounds	Rec. Sugar Pounds	Beets Tons	Sucrose Percent	Rec. Sucrose Percent
HH22	11,621	10,163	35.42	16.47	14.51
Y731H8	12,111	10,591	35.79	16.89	14.80
Y731H29	12,233	10,591	37.27	16.44	14.16
Y741H8	12,478	10,805	37.27	16.65	14.48
Y741H29	12,111	10,484	36.90	16.39	14.11
Y740H8	11,988	10,484	36.90	16.34	14.22
Y740H29	11,866	10,270	36.90	16.12	13.90
Average of tests	12,233	10,698	36.90	16.62	14.52
LSD (.05)	489	428	1.48	0.25	0.30
C.V. (%)			2.4	1.5	

Variety	Qual. Index	Relative Quality Data			
		K	Na	NH_2-N	K+Na
HH22	88.0	97	69	100	92
Y731H8	87.6	99	100	100	99
Y731H29	86.2	101	117	99	110
Y741H8	86.9	104	108	99	105
Y741H29	86.2	110	110	100	110
Y740H8	86.9	101	104	101	102
Y740H29	86.2	108	104	101	108
Average of tests	87.3	100	100	100	100
LSD (.05)	0.6				

BREEDING FOR RESISTANCE TO ERWINIA ROOT ROT

R. T. Lewellen, E. D. Whitney, I. O. Skoyen

Breeding for resistance to soft rot of sugarbeet incited by Erwinia was continued in 1979. Selection for resistance to soft rot was an objective in 18 breeding lines with concurrent selection pressure exerted for resistance to BWYV, nonbolting tendency, root size, shape, and/or sucrose content. In injury-inoculated tests at Salinas and Spence, approximately 120 breeding lines and hybrids were evaluated for reaction to Erwinia and powdery mildew.

Advanced soft-rot resistant breeding lines were evaluated in hybrid combinations at Salinas, Brawley, and in cooperation with sugar company researchers. The hybrids with the C36 pollinator continued to have sugar yield performance characteristics similar to those with the C13 or C17 pollinators, e.g., US H9 and US H10. An official USDA-SEA-AR release in cooperation with the Beet Sugar Development Foundation and the California Beet Growers Association was made that designated the C36 hybrid with 546H3 as US H11.

US H11 thus combines resistance to Erwinia with previously existing levels of other multiple disease resistance and yielding capacity. Currently then, one of the greatest sugarbeet breeding challenges in California is to develop breeding lines and cultivars with greater productivity but still have them adequately protected by existing levels of multiple disease resistance. Several hybrids developed outside of California and certain of our own experimental hybrids are known to possess significantly improved yielding capacity (particularly for percent sucrose) but in most instances these hybrids are highly vulnerable to one or more of the prevalent diseases, e.g., root rot, virus yellows, curly top, etc.

Breeding for resistance to soft rot can not be maintained as a totally separate project but must be integrated into the comprehensive breeding program. In Table 1, several of the most advanced and promising lines from this program are compared to C13, C17, and C36 for resistance to Erwinia. After two cycles of resistance selection, improvements for resistance have been significant but in comparison to C36, these lines remain moderately susceptible and additional cycles of selection for resistance are needed. During the second cycle of selection in the development of these lines, combined selections were practiced for soft rot resistance, yellows resistance, and sugar yield. 1979 field tests have shown that both resistance to yellows and sucrose content were improved but little gain was realized for rot resistance. We are currently re-evaluating this multiple selection technique. Although a negative linkage is suggested between yellows resistance and rot resistance, we believe that a modification in the disease inoculation and selection sequence will allow concurrent improvements for both traits.

Table 1. Reaction of USDA breeding lines to Erwinia after 0, 1, 2, or 3 cycles of selection for resistance.

Breeding Line	% Rot/Beet*			
	Cycle 0	Cycle 1	Cycle 2**	Cycle 3
C13	77	--	--	7 (C36)
C17	71	54	27	
Y31	41	23	22	
Y40	36	24	23	
Y41	27	22	16	
Y46	--	20	22	

*Mean of two injury-inoculated tests, 1979.
**Combined selection for BWYV and soft rot resistance.

Several small commercial lots of US H11 seed were produced in 1978. Two of these were evaluated in Salinas trials in 1979 and compared to US H10B and an equivalent of US H11 produced at Salinas. A summary of these tests is shown in Table 2. The productions of US H11 did not differ appreciably for yield performance or reaction to Erwinia. The two US H11 seedlots produced in Oregon had a similar frequency of bolters but both had fewer than the US H11 production at Salinas. A Spreckels' C36 hybrid, SSE1, is not included in the summary below but appeared to have similar performance as the US H11 seedlots.

Table 2. Comparison of US H10B and US H11 seed productions at Salinas in 1979.

Hybrid	Acre Yield		% Sucrose[1/]	% Rot/ Beet[2/]	% Bolting[3/]
	Sugar (lbs)	Beets (T)			
US H10B	11,720	39.35	14.85	37.6	19.6
US H11 (78016)[4/]	11,380	38.94	14.57	5.2	10.5
US H11 (78050)[5/]	11,310	38.23	14.74	5.9	10.1
US H11 (E736H8)[6/]	11,070	37.65	14.69	6.8	16.4

1/ Summarized from Tests 479, 679, and 1579.
2/ Mean of two injury-inoculated tests.
3/ Summarized from Tests 279, 279B, and 479.
4/ Union Sugar's production at Medford, Oregon.
5/ American Crystal's production at Salem, Oregon.
6/ USDA's production at Salinas in 1977.

EVALUATION OF HYBRIDS AND BREEDING LINES TO
ERWINIA ROOT ROT AND POWDERY MILDEW, 1979

Variety	Description	Test 2279 (Spence)[1] DI[3]	% Resist.[4]	PM[5] 9/17	Salinas, 1979[2] DI	% Resist.	PM[6] 8/27	PM[6] 9/4
OPEN-POLLINATED LINES								
Y823	Inc. Y723	36.2	52.3	1.5	35.0	50.0	2.0	3.0
Y826	Inc. Y726	24.8	67.2	2.0	55.6	24.0	3.0	4.0
Y830	Inc. Y730	46.6	44.6	5.0	84.7	3.7	8.0	8.0
468	Inc. 868 (US 75)	20.0	65.1	4.0	47.5	30.8	6.0	6.0
F70-13	Inc. F66-13 (0268)	58.7	30.2	4.0	82.8	3.4	--	8.0
813	Inc. 413C (C13)	69.4	21.7	3.5	95.5	0.0	--	--
E536	Inc. E-#'s (C36)	6.2	89.7	3.0	16.6	71.2	6.0	7.0
E736	Inc. E536 (C36)	7.9	85.7	3.0	7.9	88.0	6.5	8.0
F77-36	Inc. C36 (7322)	10.2	81.6	3.0	16.3	71.7	7.0	7.5
F78-36	Inc. F77-36 (78087)	6.1	88.6	3.5	8.6	80.4	7.5	7.5
E836/2	Inc. E736 (Iso.)	4.1	91.5	3.5	12.3	76.3	7.0	7.5
E840	Inc. E640	94.6	0.0	4.5	99.7	0.0	--	--
417	Inc. 713A (C17)	52.3	33.9	3.0	90.0	4.1	--	--
E637	Inc. E537	36.9	52.9	3.5	72.0	14.3	5.0	7.0
E837	Inc. E737	16.5	74.2	3.5	38.9	42.9	5.0	6.0
Y839	YRS Y639	18.2	76.7	1.5	21.2	67.3	3.0	4.5
Y631	Inc. Y331 (C31)	30.8	60.7	1.5	51.0	32.6	3.5	5.0
Y731	Inc. Y631E (C31E1)	18.9	76.8	2.0	27.9	55.4	4.0	5.5
Y831E	YRS Y631E (C31E2)	13.2	81.1	1.5	32.1	51.0	3.5	4.5
864	Inc. 364, 464 (C64)	6.7	87.8	2.0	9.4	84.2	3.0	4.0
Y440	Inc. (C17 x C64)	27.4	67.2	2.5	44.7	39.6	4.0	5.0
Y740	Inc. Y640	11.5	78.5	3.0	36.3	50.9	5.0	6.0
Y840	YRS Y640	13.5	84.4	2.5	31.8	58.5	5.5	6.0
Y441	Inc. (C01 x C64)	18.6	73.4	1.5	33.8	42.3	2.0	3.0
Y741	Inc. Y641	14.5	79.7	1.5	29.4	63.0	2.0	3.0

1/ Test 2279 at Spence Field. 1-row plots, 24 ft. long, 2 replications. Planted May 31, 1979. Injury-inoculated August 2, 1979. Scored for root rot November 13-14, 1979.

2/ Test at Salinas. 1-row plots, 20 ft. long, 2 replications. Planted May 2, 1979. Injury-inoculated July 19, 1979. Scored for root rot November 5, 1979. Portions of replication I were not included because of severe Aphanomyces infection.

3/ DI = Disease Index = Σ% rot/no. of roots. Roots scored on a scale of 0, 1(VN), 7, 25, 50, 75, 93, and 100% rot.

4/ Roots with scores of 0 to 7% were considered resistant.

5/ PM = Powdery mildew scores. Severity of infection remained relatively low due to late planting, use of sprinkler irrigation, and heavy dews. Rated on a scale from 0 to 9.

6/ PM was very severe. Ratings should be reliable. Test was only furrow irrigated and sulfur was not used on adjacent, earlier planted tests. Plots with severe root rot were either not scored or scores may have been influenced by effects of Erwinia on canopy development. Rated on a scale of 0 to 9.

EVALUATION OF HYBRIDS AND BREEDING LINES TO
ERWINIA ROOT ROT AND POWDERY MILDEW, 1979

		Test 2279 (Spence)			Salinas, 1979			
			%	PM		%	PM	
Variety	Description	DI	Resist.	9/17	DI	Resist.	8/27	9/4
Y841	YRS Y641	13.9	84.1	1.0	19.0	66.7	1.0	2.0
Y746	Inc. Y646	16.6	76.6	2.0	22.6	58.3	2.0	3.0
Y846	YRS Y646	14.4	77.9	2.5	29.5	63.0	2.0	3.0
Y842	YRS Y642	11.9	76.1	4.0	15.2	82.6	5.5	6.5
834	Inc. 534 (1965-C534)	9.8	84.8	4.0	27.6	53.8	3.0	4.5
704-13	Inc. 604-13	51.2	34.9	4.5	66.1	14.6	5.0	6.0
804-13ER	Inc. 604-13 ERS	40.5	45.3	3.5	43.1	32.7	7.5	8.0
704-15	Inc. 604-15	62.7	22.4	3.5	86.3	8.0	2.5	5.0
804-15ER	Inc. 504-15 ERS	63.2	29.8	3.5	88.6	8.2	3.0	5.0
HYBRIDS								
US H9B	546H3 x C13 (1050)	39.0	40.8	5.0	36.8	47.2	7.0	8.0
US H10B	546H3 x C17 (86169)	32.8	52.6	4.5	42.3	39.7	5.5	7.0
E536H8	546H3 x E-#'s	7.7	86.1	3.5	5.4	92.3	5.5	7.0
E736H8	546H3 x E536 (C36)	4.8	91.4	3.5	8.7	88.0	6.5	7.5
AC 836H8	546H3 x F77-36 (78050)	5.0	90.3	3.5	6.7	94.9	6.5	7.5
U836H8	546H3 x F77-36 (78016)	4.9	92.6	4.0	5.4	89.8	6.0	7.5
SSE1	mm x F77-36 (Sprex)	2.6	93.9	4.0	5.2	87.9	6.0	7.0
HH27	Holly Hybrid	3.1	94.6	1.5	18.5	66.1	1.0	1.5
E840H8	546H3 x E640	30.3	57.5	5.0	57.3	22.2	7.0	7.5
717H8	546H3 x 417 (C17)	19.0	73.0	5.0	46.5	32.1	6.5	8.0
E837H8	546H3 x E737	7.6	87.8	4.0	26.3	58.2	6.0	7.0
8717H8	546H3 x 7717	7.2	84.5	3.5	24.1	62.5	5.0	6.0
8719H8	546H3 x 6719	13.0	80.0	3.0	25.8	64.8	4.5	6.5
E840H12	7546EH4 x E640	36.1	45.9	4.0	85.3	0.0	5.5	7.0
E836H12	7546EH4 x E736	3.8	93.8	4.0	10.1	80.0	5.0	8.0
464H8	546H3 x F66-64	11.6	77.9	3.0	22.8	58.6	3.0	4.0
US H8	546H3 x NB7 (Holly)	20.5	68.9	4.5	30.8	34.6	4.0	6.0
Y631H8	546H3 x Y331 (C31E0)	22.4	67.6	3.0	44.6	37.0	3.0	5.0
Y731H8	546H3 x Y631E (C31E1)	16.4	75.4	3.5	33.4	38.5	3.0	5.0
Y731H33	546H72 x Y631E	13.8	76.9	3.0	43.4	36.8	3.5	5.5
Y831H12	7546EH4 x Y631E	14.2	78.7	3.0	39.9	43.1	4.0	5.5
SELF-FERTILE, RANDOM-MATING LINES								
8740	7740Baa x A	41.6	45.6	3.0	48.8	31.3	4.5	6.0
8741	7741Baa x A	30.5	46.2	4.0	36.4	32.7	4.0	6.5
8742	7742aa x A	23.5	60.3	3.0	33.4	48.0	4.5	6.5
3789	2775,6aa x A	21.6	64.8	3.0	51.2	34.5	4.5	6.5
8744	7744aa x A	30.5	56.9	4.0	45.9	38.9	4.5	6.5
8789	ERS 6789 (A,aa)	25.0	66.7	2.0	34.7	47.2	3.5	4.5
3790	2775, ... aa x A	27.3	57.1	3.5	43.5	29.1	5.5	6.5
8745	7745aa x A	32.4	52.4	4.5	57.6	17.9	4.0	5.5
8790	ERS 6790 (A,aa)	9.8	86.8	3.5	21.2	67.3	3.5	5.0

EVALUATION OF HYBRIDS AND BREEDING LINES TO ERWINIA ROOT ROT AND POWDERY MILDEW, 1979

		Test 2279 (Spence)			Salinas, 1979			
			%	PM		%	PM	
Variety	Description	DI	Resist.	9/17	DI	Resist.	8/27	9/4
8746	ERS 6746-1,2,3,4(A,aa)	15.4	78.5	4.0	39.0	41.8	4.5	5.5
8755	7755Baa x A	32.6	51.6	3.0	66.5	15.2	2.5	4.0
7755	6755aa x A	34.2	50.0	3.0	71.4	15.8	3.0	4.5
8796-1	YRS 6796-1 (A,aa)	44.4	44.8	4.0	79.6	12.5	5.5	6.5
8796-2	YRS 6796-2 (A,aa)	13.7	78.1	4.0	45.1	33.3	5.5	7.5
8792	ERS 6792 (A,aa)	15.7	74.2	1.5	25.3	61.7	3.0	3.5
8793	ERS 6793 (A,aa)	12.2	78.8	2.5	14.2	82.4	5.0	7.0
8794	ERS 6794 (A,aa)	14.9	71.2	3.0	22.2	55.6	6.0	8.0
8795	ERS 6795 (A,aa)	9.2	85.9	3.0	25.2	65.4	5.0	7.0
8798	ERS 6798 (A,aa)	19.6	74.2	3.0	63.2	26.3	1.0	3.0
SELF-FERTILE LINES AND F_1 HYBRIDS								
8717	Inc. 7717	14.6	80.3	2.0	35.0	46.9	4.0	6.0
8719	Inc. 6719	7.7	89.2	2.0	30.2	51.9	2.0	4.5
8719C1	ERS 6719⊗	12.1	77.4	3.0	39.5	52.6	3.0	5.0
8719BC1	6719⊗	9.3	84.4	3.0	25.0	62.1	1.0	4.0
8720C1	YRS 6212⊗	36.8	57.6	2.0	68.9	20.8	1.0	4.0
8721C1	YRS 6211⊗	51.2	34.4	3.0	85.5	3.6	4.0	6.0
8722C1	YRS 6209⊗	23.6	70.0	3.0	58.8	26.8	4.5	6.0
7758-1	Inc. 6758-1	28.4	65.7	4.0	64.4	17.3	4.0	6.5
7758-3	Inc. 6758-3	42.9	36.4	3.5	76.9	15.3	3.0	5.0
8779	Inc. 7779 (C779)	33.4	60.3	0.5	83.9	11.5	0.0	1.0
F66-562	Inc. 562 (6618)	25.0	56.9	5.0	43.3	31.3	3.0	6.0
8563	Inc. F67-563	13.3	66.7	4.0	47.4	16.7	4.5	7.0
7563-30	Inc. 6563-30				15.0	71.4	5.0	7.0
F74-718	Inc. C718 (4170)	37.8	54.3	3.0	86.5	5.5	3.5	6.0
F78-546	Inc. F70-546 (78156)	5.0	91.0	3.0	12.4	77.2	3.0	4.5
7546E	ERS F70-546	5.9	90.4	3.0	12.9	82.1	2.0	4.0
8569	Inc. F66-569	8.9	83.3	6.5	10.5	76.3	5.0	7.0
4539	Inc. F63-539	25.0	65.1	4.5	57.3	18.2	4.0	5.5
F78-546H3	562HO x 546 (78155)	8.0	82.6	5.0	19.8	68.5	4.0	5.5
3546H72	718HO x F70-546	6.0	88.9	4.5	37.1	45.2	4.5	6.5
7551H4	F67-563HO x 5551	15.9	69.2	5.5	38.0	38.0	5.0	6.0
8536H72	F74-718HO x F75-536	37.7	43.1	6.5	59.7	31.4	3.0	5.0
8536H22	6522-29HO x F75-536	33.7	56.1	6.0	77.7	15.6	3.5	4.0
8779H72	F74-718HO x 7779	24.7	62.3	2.5	65.9	28.0	1.5	4.5

EVALUATION OF HYBRIDS AND BREEDING LINES TO
ERWINIA ROOT ROT AND POWDERY MILDEW, 1979

Variety	Description	Test 2279 (Spence) DI	% Resist.	PM 9/17	Salinas, 1979 DI	% Resist.	PM 8/27	PM 9/4
TEST 2279-2 7/								
864H72	718H0 x 364 (C64)	30.8	60.0	2.0				
Y823H72	718H0 x Y723	16.6	77.1	2.0				
Y826H72	718H0 x Y726	21.6	71.9	2.5				
Y831H72	718H0 x Y631E (C31E1)	22.2	67.3	3.5				
Y731H72	718H0 x Y631E (C31E1)	17.2	73.2	3.5				
Y631H72	718H0 x Y331 (C31E0)	26.8	65.0	3.0				
Y731H33	546H72 x Y631E (C01E1)	9.8	89.5	2.5				
Y601H72	718H0 x Y401A (C01)	25.9	64.5	3.5				
E840H72	718H0 x E640	55.5	28.6	4.5				
8717H72	718H0 x 7717	16.2	75.8	3.5				
8719H72	718H0 x 6719	17.4	73.2	3.5				
717H72	718H0 x 417 (C17)	39.4	39.0	4.5				
Y717H72	718H0 x Y617 (C16)	32.0	55.4	2.5				
717H33	546H72 x 417 (C17)	30.8	55.7	2.5				
E836H72	718H0 x E736	5.8	88.1	4.5				
E837H72	718H0 x E737	24.8	66.7	5.0				
U836H8	546H3 x F77-36 (78016)	1.9	95.5	4.0				
US H10B	546H3 x C17 (86169)	13.6	82.9	4.5				
MonoHy D2	GW lot 77-115	11.8	83.3	4.0				
1443	Beta Seed	20.2	69.8	1.5				
Hh Mono 545	Hilleshog diploid	34.6	54.0	2.0				
Monatunno	K19307 (3n)	23.0	72.2	3.0				
Hh 2X Mono 81	Hilleshog Exp. VYR Hyb.	25.2	63.5	3.5				
Hh Mono 774	Hilleshog Exp. VYR Hyb.	24.8	50.8	3.5				

7/ These hybrids were tested only at Spence Field. A combination of poor soil and weak plant growth caused disease incidence to be lower than expected.

Fusarium Stalk Blight Resistance

J. S. McFarlane

A Fusarium stalk blight resistance test was conducted at Salem, Oregon, in cooperation with the West Coast Beet Seed Company. The planting was made in late September and winter losses were severe. Stands of the remaining lines were poor and infection was less severe than in previous years. The plants were classified for root necrosis on August 16. Lines showing good resistance in previous years again received good ratings. Hybrids between resistant and susceptible lines were highly resistant suggesting that resistance is dominant and perhaps simply inherited. A selection from the widely used C563 inbred showed good resistance. A listing of the lines that were classified with their Fusarium grade follows.

Entry	Description	Grade[1/]
8101	6564HO x 6554	.04
8102	7564aa x 6554	.05
7554	Inc. NB4 inbred	.08
8554	Inc. S_{14} NB4	.09
Y731	Yellows res. line	.09
F77-36	Inc. Erwinia res. sel. C13	.17
F70-17	Inc. C17	.21
E837	Inc. Erwinia res. sel. C17	.23
7563-30	Fusarium res. sel. F67-563	.25
F70-13	Inc. C13	.27
8505H2	1502HO x Fus. res. selections	.42
F69-546H3	562HO x 546	.50
1502	NB1 inbred	.63
6564H1	(502HO x 563) x 4564C1	.67
8505HO	F67-563HO x Fus. res. selections	.76
8564Aa	4564aa x 5564	1.36
7522H21	536-97HO x 522	1.73
4564aa	Mendelian MS of 564	2.16
8563aa	Mendelian MS of 563	2.23
8564aa	4564aa x 5564Aa	2.36

1/ Stalk blight rated on a scale of 0 to 4 with 0 = no disease and 4 = dead plant.

Field Evaluation of Root Toughness in Sugarbeet

I. O. Skoyen and R. T. Lewellen

Studies were continued in 1979 on root toughness (fiber content of roots) of sugarbeets. Earlier field studies have been reported in Sugarbeet Research--1977 Report, pages A77-A80 and -1978 Report, pages A77-A81. Evaluation of plant age vs. root toughness was conducted in two tests seeded nearly three months apart. In addition, seed increases of hybrids with "soft" and "tough" selections were made in 1979.

Materials and Methods--Two tests, each with 16 entries, were seeded November 15, 1978 and February 7, 1979. The tests included representative monogerm hybrid varieties, monogerm and multigerm open-pollinated lines, a monogerm F_1 hybrid, and monogerm inbred lines developed at the U.S. Agricultural Research Station, Salinas, California. Root toughness was measured on a single plant basis as ft. lbs. pressure required for a blade to penetrate a root 2.54 cm deep. Measurements were made in half pound increments. Transverse probes were made 1 to 2 inches below the crown.

In 1979, as in 1978, an Effegi penetrometer (used to test fruit firmness at maturity) was used to make root toughness measurements. The blade used measured 1 mm x 10 mm (10 sq mm cross section) x 2.54 cm long. The dial of the Effegi penetrometer has a graduated dial capacity of 27 ft. lbs. pressure but pressures to 28 ft. lbs. can be readily interpreted. Root probe measurements were made in the field during the last two weeks of October 1979.

Results and Discussion--As was demonstrated in the 1977 and 1978 tests, mean root toughness varied within and between lines in 1979 (Table 1). The 1979 data also showed that age of plants was a primary factor in root toughness with the younger roots from Test 2 averaging three foot pounds less than the older roots of Test 1. Two of the tougher lines in Test 1, 8744 and F67-563, were also the toughest in Test 2, however, other lines often differed in toughness between the tests.

Bolting ranged from 7% for 417 (Ore.) to 62% for F63-563 in Test 1. However, bolting per se was not observed to be a particular condition to root toughness in Test 1 even though it has long been considered a contributing factor in root toughness. The line, Y741, bolted 44% and was significantly less tough than US H11 which bolted only 12%. The increase in root toughness as beet plants aged was also expressed in the higher number of plants that required over 28 ft. lbs. pressure before the probe blade penetrated the root. In Test 1 the mean for extra tough roots was over 10% of all roots measured and ranged from 0.7% to 25% among varieties, whereas in Test 2 the mean was 1.0% of the roots measured.

Arranging toughness measurements into frequency classes showed that, as was observed in 1977 and 1978, a broad range of toughness within lines also occurred in 1979 (Table 1). In Test 1, the 12- to 20-lb. portion of the distribution accounted for 69% of the "softest" variety and 29% of the "toughest." This 12- to 20-lb. portion accounted for 90% of the plants for the "softest" and 61% for the "toughest" variety in Test 2. The mean for Test 1 was 52% and for Test 2 was 78%.

Table 1: Sugarbeet root toughness comparisons for two seeding dates, 1979

Variety	Description	Test 1, Seeded 11/15/78					Test 2, Seeded 2/7/79				
		Roots Probed (28 lbs or less)			Roots 28+ lbs on scale		Roots Probed (28 lbs or less)			Roots 28+ lbs on scale	
			Mean[1/]	Std. dev.		28+/ total		Mean[1/]	Std. dev.		28+/ total
3-way hybrids		No.	Ft. lbs	s	No.	%	No.	Ft. lbs	s	No.	%
464H8	US H7A	135	20.13	3.43	6	4.3	165	17.16	3.08	--	--
U617H8	US H10	122	20.16	3.79	16	11.6	156	18.17	3.41	4	2.5
U836H8	US H11	139	21.37	4.27	24	14.7	164	17.66	3.83	2	1.2
O. P. lines											
468	US 75	139	19.64	3.66	14	9.2	151	18.35	2.56	--	--
864	Inc. F66-64	123	19.52	3.42	1	0.8	158	17.84	2.77	--	--
417(Ore)	Inc. 813 Ore	99	19.93	3.56	14	12.4	128	17.03	3.35	2	1.5
F78-36	Inc. F77-36	135	20.27	4.37	26	16.1	125	17.09	3.42	3	2.3
8744	Inc. 7744aaYA-	93	20.88	3.89	20	17.7	140	19.41	3.41	6	4.1
Y731	Inc. Y631E	143	18.94	3.68	1	0.7	146	17.29	2.63	1	0.7
Y639	Inc. Y439	138	19.23	4.03	17	11.0	162	18.06	3.03	--	--
Y740	Inc. Y640	139	18.94	4.16	10	6.7	168	17.28	2.58	--	--
Y741	Inc. Y641	125	19.49	3.92	7	5.3	161	18.15	2.76	1	0.6
F1 hybrids											
F78-546H3	562HOx546	155	20.39	3.96	6	3.7	162	17.95	3.17	--	--
Inbred lines											
F[illegible]-562	Inc. F61-562	93	20.69	4.50	31	25.0	101	17.37	3.36	1	1.0
F[illegible]-563	Inc. F63-563	80	22.21	4.58	26	24.5	136	19.30	3.94	3	2.2
[illegible]46	Inc. F70-546	145	19.69	4.01	6	4.0	131	17.84	2.43	--	--
		125.2	20.92	3.95	14.1	10.5	147.1	17.87	2.90	1.44	1.0
LSD .5		$2\sqrt{2(15.6)}/125.2$	0.99				$2\sqrt{2(8.41)}/147.1$	0.67			
C. V. (%)			18.8					16.2			

[1/] Blade dimension for probing was 1 x 10 mm (10 sq mm area) x 2.54 cm long.

Table 1: (Continued)

Variety	Frequency Distribution of Root Toughness (Pounds Pressure)													
	Test 1, Seeded 11/15/78						12-20 Classes Total Probed %	Test 2, Seeded 2/7/79						12-20 Classes Total Probed %
	12-14	15-17	18-20	21-23	24-26	27-28+		12-14	15-17	18-20	21-23	24-26	27-28+	
3-way hybrids														
US H7A	11	28	36	40	13	12	53.6	45	55	44	13	8	0	87.3
US H10	9	23	36	26	20	23	49.6	34	45	46	22	7	7	77.6
US H11	7	26	33	26	27	44	40.5	35	60	32	24	9	6	76.5
O. P. lines														
US 75	13	32	47	23	17	21	60.1	27	39	45	33	6	0	74.0
864	12	30	27	38	11	6	55.6	37	59	44	22	7	1	82.3
417(Ore)	14	15	28	19	13	24	50.4	41	39	31	8	9	2	85.4
F78-36	13	31	32	24	19	42	47.2	36	45	44	31	16	5	70.6
8744	6	16	23	28	11	29	39.8	12	33	48	33	10	10	63.7
Y731	18	46	35	25	12	8	68.8	28	51	42	11	3	1	82.9
Y639	16	46	27	27	16	24	57.1	25	57	42	30	6	2	76.5
Y740	23	42	32	20	15	17	65.1	35	53	63	14	3	0	89.9
Y741	13	35	38	20	11	16	64.7	25	52	48	25	11	2	76.7
F_1 hybrid														
F78-546H3	15	37	31	38	25	16	51.2	25	58	47	23	8	1	80.2
Inbred lines														
F66-562	10	25	15	13	21	40	40.3	24	40	20	10	5	3	82.3
F67-563	3	13	15	12	18	45	29.2	22	37	26	27	13	14	61.1
F78-546	15	34	43	25	19	15	60.9	15	48	47	19	4	0	82.7
Mean	12.4	29.9	31.1	25.2	16.8	23.9	52.1	29.1	48.2	41.8	21.6	7.8	3.4	78.1

A comparison of environmental effects, such as climatic and soil influences, for the 1977, 1978, and 1979 field tests indicate that conditions probably were comparable for all tests conducted to this point except Test 2 in 1978. Test 2 in 1978 was established under very wet soil conditions during a brief interruption in a rainy period, and subsequent rains kept the field saturated for weeks. The original stress conditions were evident throughout the growing season and the roots were the toughest encountered in three years of testing.

Obviously, more precise measurements of environmental and varietal effects are needed and will be made in the progeny tests of selections for "softer" and "tougher" beets. The progeny of selections from four sugarbeet lines and their corresponding 3-way hybrids in which the selections served as pollinators will be tested in 1980 field tests.

INTERSPECIFIC HYBRIDIZATION

Cytogenetical Studies in *Beta* Species

M. H. Yu

Accession of the true breeding nematode resistant sugarbeet and the performance of its progeny

It has been several years since the diploid sugarbeet plants with cyst nematode resistance were recovered from the later generation progeny of the interspecific hybrid between *Beta vulgaris* and *B. procumbens*. However, no bred-true nematode resistant sugarbeet genotypes were obtained from various attempts either under controlled or uncontrolled pollinations. The transmission rate of nematode resistance has always been lower than expected if one major gene determines the resistance. Self-pollination and cross pollination of the resistant heterozygous plants resulted in a larger portion of progeny with the resistance. The meiotic chromosomal behavior of these diploids was not completely normal.

Presently, more than 40 self-fertile sugarbeet families have been examined for nematode resistance (Table 1). In one of these families all 67 plants carried the resistance, i.e., there were no nematode susceptible sugarbeets segregating in this group. This indicated that in spite of the meiotic abnormalities of the parents, about 2.5% of the self-pollinated resistant heterozygous sugarbeets of this source yielded bred-true, probably homozygous, nematode resistant progeny. A few seeds were harvested from several of the 67 plants. Table 2 shows the performance of nematode resistance in progenies of the S_3 generation that have been tested. It is obvious that the transmission rate of nematode resistance was very high, if not complete, for both the selfed and open pollinated progenies of plant 3584. The two plants classified as nematode susceptible contained 11 and 15 cysts respectively, which was only 5 cysts beyond the arbitrary criterion of 10 or less cysts per plant for resistance in our screening procedure. This was in contrast to the abundance of cysts on root systems of the susceptible sugarbeets. Plant No. 783 was undoubtly a heterozygous resistant plant, most likely resulting from the fertilization of a contaminated pollen grain. This plant was morphologically different from all others in the same group by its erect, tall, and vigorous growth habit.

Plant 3584 demonstrated that nematode resistant homozygotes in sugarbeet can be produced, but at a low frequency. Sugarbeet with bred-true nematode resistance should also be obtainable from cross-pollination of self-sterile plants with the resistance. However, two plants, both homozygous in nematode resistance, are required in order to produce all progeny that bred-true in the following generations. Reciprocal crosses between a resistant homozygote and a resistant heterozygote (or even a susceptible parent) could produce all the progeny with the resistance from either side of the family, provided no foreign pollen contaminated them. In these cases the proportion of progeny homozygous for the resistance will depend on the rates of resistance transmission through egg and pollen of the heterozygous parent. Further progeny tests are necessary to identify those individuals breeding true for nematode resistance.

Growth profile and chromosome movement of a haploid sugarbeet

The haploid sugarbeet plant, selection 2116, was recently identified. It was distinguishable from normal diploids at the seedling stage by its narrow, thin, and concave leaf lamina, elongated petiole, and the less vigorous growing profile. After photothermal induction, this haploid was moved to a greenhouse under an 18 hour daily photo period. It formed a smaller than normal seed stalk, yet the inflorescence was normally developed. The number of flower buds was also small.

All the pollen mother cells examined were haploid, i.e., 9 chromosomes. This was not the case, however, for the root-tip chromosome counts where a few roots contained 18 chromosomes. There were undoubtedly chimeral sectors in this plant.

At meiotic metaphase univalents were usually shaped like blobs with no well defined arms and were irregularly scattered in the cells. Varied frequencies of univalents, bivalents, trivalents and the secondary associations appeared. Though lacking in metaphase orientation, weak spindle fiber forces seemed to be acting in the movement of univalents. In a majority of cells the nine univalents assorted into two unequal groups and migrated to the poles at anaphase I with all possible numerical combinations (Table 3). Distribution of 4-5 chromosomes were the most frequent type and occurred in about 37% of the total counts. Approximately 11% of the cells had one to six laggards in the spindle. Occasionally one or more lagging univalents underwent division; the divided univalents generally moved toward the opposite poles. At telophase I varying sizes and numbers of nuclei were observed, including the restitution nuclei which contained all the 9 component chromosomes.

The second metaphase chromosomes seemed better oriented than the first, but the chromosomal movement at anaphase II was frequently more irregular with the occurrence of laggards and spindle abnormalities of various types. Different sizes and numbers of monads, dyads, triads, tetrads, and pentads were present at sporad stage. The size of pollen grains measured ranged between 8 and 20 microns, but most were between 10 to 16 microns, in diameter. Pollen grains that were smaller than 18 microns would likely be nonfunctional. This monoploid plant did not set seed.

Table 1. Nematode resistance transmission in the progeny of self-pollinated resistant sugarbeets.

Source NR parents[1]	Number of progeny plants			% of NR progeny
	Tested	NR	NS	
0536	26	15	11	57.6
3550	42	18	24	42.8
3554	84	28	56	33.3
3559	45	22	23	48.8
3562	11	5	6	45.4
3564	31	12	19	38.7
3566	42	21	21	50.0
3567	38	17	21	44.7
3568	81	25	56	30.8
3575	42	24	18	57.1
3580	41	13	28	31.7
3582	39	17	22	43.5
3584[2]	67	67	0	100
3589	3	2	1	66.7
3594	63	26	37	41.2
3596	89	25	64	28.0
3600	25	8	17	32.0
3602	68	28	40	41.1
0238	11	4	7	36.3
3460	79	38	41	48.1
3461	27	16	11	59.2
3463	35	20	15	57.1
3464	101	41	60	40.5
3465	26	12	14	46.1
3481	4	2	2	50.0
Sum[2]	1053	439	614	41.7%

[1] 17 other families, including self-sterile, also showed segregations on the resistance.

[2] Plant No. 3584 was considered to be a true-bred; excluded from calculation in this table.

Table 2. Transmission of nematode resistance in plant 3584 and its progeny.

Source	# Plants tested	# NR plants	# NS plants	Remarks
3584 ⊗[1]	67	67	-	Plant No. 783[2] with erect growing habit.
3584 O.P.[1]	28	28	-	
	95	95 (100%)	-	
Progeny of 3584 ⊗-				
731 ⊗	2	2	-	
733 ⊗	8	8	-	
733 O.P.	11	11	-	
737 ⊗	8	8	-	
743 ⊗	2	2	-	
744 ⊗	8	8	-	
745 ⊗	6	6	-	
747 ⊗	2	2	-	
749 ⊗	3	3	-	
750 ⊗	6	6	-	
751 ⊗	11	11	-	
755 ⊗	5	5	-	
759 ⊗	10	10	-	
765 ⊗	19	19	-	
766 ⊗	12	12	-	
768 ⊗	5	5	-	
770 ⊗	9	9	-	
770 O.P.	41	40	1	11 cysts on the NS plant.
771 ⊗	14	14	-	
775 ⊗	5	5	-	
775 O.P.	1	--	1	15 cysts on the NS plant.
778 O.P.	1	1	-	
779 O.P.	1	1	-	
	190	188 (99%)	2	
783[2] ⊗	15	7 (47%)	8	Abundance of cysts on the NS plants.

[1] ⊗ = self pollinated; O.P. = open pollinated.

[2] Plant No. 783 was heterozygous for the resistance, probably as a result of pollen contamination.

Table 3. Segregation of univalents to the poles at anaphase I in the haploid sugarbeet plant 2116.

Chromosome distribution	No. of cells observed	%
9-0	4	0.5
8-1	55	6.7
7-2	139	17.0
6-3	216	26.5
5-4	301	36.9
With 1 laggard	29	3.6
" 2 laggards	25	3.1
" 3 to 6 laggards	36	4.4
Chromosome divided	11	1.3
Total	816	100

INTERSPECIFIC HYBRIDIZATION

VULGARIS-PROCUMBENS HYBRIDS

Helen Savitsky

The populations of diploid nematode-resistant plants are similar to the usual populations of diploid sugarbeet. After several hybridizations with sugarbeet the nematode-resistant plants acquired many morphological characters of sugarbeet. These characters are controlled by different genes in the chromosomes of a normal B. vulgaris plant. No characters peculiar to B. procumbens caused by the deleterious genes of wild species have been observed in diploid nematode-resistant plants. We are now working with nematode-resistant diploid sugarbeet populations.

The main objective of the work is to study transmission of resistance to the following generations and the development of homozygous nematode-resistant plants, all offspring of which will be resistant. Only then can the incorporation of nematode resistance into commercial varieties be effective.

For development of homozygous nematode-resistant plants the F_1 and F_2 nematode-resistant self-fertile and self-sterile hybrids were obtained after hybridization of nematode-resistant plants with inbreds and intercrosses of self-sterile plants. The majority of these F_1 nematode-resistant plants crossed with nematode-susceptible plants transmitted resistance to 17-18% of plants in their F_2 progenies. Only a few plants showed higher transmission rates.

Although the transmission by pollen is much lower than the transmission by female gametes, the mutual transmission of resistance by female and male gametes considerably increased the rate of resistance transmission in the hybrids. To study the transmission of nematode resistance from 57 F_1 self-fertile hybrids the 3,335 F_2 plants were tested for resistance. In 43 self-sterile hybrids derived from intercrosses of self-sterile resistant plants 2,016 F_2 plants were also tested for resistance. Data concerning transmission rates from F_1 to F_2 hybrids are summarized from 1978 and 1979 experiments. In self-fertile hybrids 64% and in self-sterile hybrids 38% of F_1 plants transmitted resistance from 25 to 40%. Many F_1 hybrids belonging to this group transmitted resistance to 33, 35, 36, 38 and 40% of the plants in their F_2 progenies. Higher transmission rates of 42, 44, 45 and 50% were observed in some F_1 self-sterile and self-fertile hybrids.

The F_2 hybrids derived from F_1 plants with higher transmission rates were selected and selfed or crossed again. F_3 seeds were obtained from some of them in 1979. Seeds from recently selected plants will be obtained in 1980.

The homozygous nematode-resistant plants may be detected starting from the F3 generation and in all following generations. The study of transmission rates in F_3 progenies of self-fertile and self-sterile hybrids was started in late 1979 and will be continued in 1980. New F_4 self-fertile and self-sterile hybrids will be obtained from selected F_3 plants to induce homozygosity in the following generations.

The first data obtained by testing the F_3 progenies indicated that transmission of resistance to F_3 progenies increased when selections were made in F_2 hybrids for higher transmission rates. Some hybrids transmitted resistance to 60% and to 70% of their offspring. Most important was the detection of a homozygous nematode-resistant plant that transmitted resistance to 100% of its offspring. The 63 plants derived from this homozygous resistant plant were all resistant. The plant used in reciprocal crosses with this homozygous plant gave 87.8% (40 plants) nematode-resistant offspring. Homozygosity now has to be restored in the offspring of a homozygous plant pollinated by a resistant heterozygote, and they have to be studied cytologically. F_3 and F_4 progenies of selected self-fertile and self-sterile plants will be tested for resistance for detection of homozygous nematode-resistant plants.

Selection of plants with higher transmission by pollen during two generations gave good results in increasing transmission rates in the hybrids. Selection of plants that give higher transmission by pollen will be continued. The cytological study of diploid nematode-resistant hybrids included the study of meiosis and determination of chromosome number in selected plants.

VULGARIS-COROLLIFLORA HYBRIDS

Two methods are used for transmission of curly top resistance from B. corolliflora to sugarbeet: 1) Repeated selections for resistance were made in the progenies of hybrids with 27 chromosomes (9 chromosomes of B. corolliflora and 18 B. vulgaris chromosomes). Seeds were obtained from 27 chromosome plants after pollination by diploid sugarbeet. 2) In order to obtain hybrids in which the resistance is determined only by B. corolliflora, tetraploid plants of the highly curly top susceptible sugarbeet line 742 were produced, and tetraploid seeds were obtained from these plants in 1979. The tetraploid plants may be used for obtaining hybrids with B. corolliflora.

The chromosome number was studied in some wild species of the section Corollinae Tran. The species B. lomatogona Fisch. at Meyer is known as a diploid species (2n=18). Determination of the chromosome number in different plants detected that in addition to diploid plants B. lomatogona also has tetraploid plants (4n=36). In B. intermedia Bunge the number of chromosomes was unknown. It is established now that B. intermedia is a tetraploid species (4n=36).

This work is conducted in cooperation with Dr. McFarlane.

SUGARBEET RESEARCH

1979 Report

Section B

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The research was supported in part by funds provided through the Beet Sugar Development Foundation (Projects 27, 64, and 69).

CONTENTS

I. EXPERIMENTAL FIELD TRIALS

J. C. Theurer & D. L. Doney

Agronomic Data

Soil Types:	North Farm - silty loam Farmington Farm - sandy loam
Fertilizer:	950 lbs/acre of 16-20-0
Planting Dates:	Farmington Farm - April 23 North Farm - May 21, 22, Replanted June 7.
Note:	The Experimental Field at North Farm was treated with 1#/acre Norton Preplant herbicide by a commercial spray company. Poor emergence occurred and chemical damage to the emerged seedlings was evident. Experiments were replanted as it was obvious that critical data could not be attained from these tests with the poor stand and evident retardation of seedling growth.
Thinning Dates:	North Farm - June 20 - 23 Farmington Farm - June 12 - 15
Irrigations:	Sprinkler irrigated at both farms until two weeks prior to harvest.
Harvest Dates:	North Farm - October 15 - 17 Farmington Farm - October 10 - 12
Harvesting Procedures:	Tops were removed by beating twice with a rotobeater then topped and dug with a two-row harvester. Beets/plot were counted as they went into a weighing basket on the harvester. Two 10-beet samples were taken at random from each two-row plot for sugar analysis. All beets in each plot were weighed to determine root yield.

A. COMMERCIAL AND EXPERIMENTAL VARIETY TEST

Thirteen of the current major commercial hybrid cultivars developed in the United States, three varieties from Europe, and several experimental varieties were evaluated at Logan and Farmington in 1979. Twenty-two of the varieties were grown at both locations. Each entry was planted in six replicates of two-row plots, 36' long, with plants thinned approximately one foot apart in the row. The Farmington plots had excellent stand, and were relatively free from curly top disease, but did show some powdery mildew infection and very little disease problems.

Sugar percentage, root yield and quality factors for these varieties are given in Tables 1 and 2. There were significant differences in the ranking of the varieties at the two locations. The best 15 varieties were not significantly better or worse for gross sugar than the most widely grown variety in this area, AH10, at Farmington. GW-D2 had the highest sugar content at this location. None of the experimental hybrids were among the best yielding entries.

At Logan, the European varieties were among those having the highest gross sugar. Beta 1237 and Ultramono had the highest sucrose content. G239, a hypocotyl diameter selection, was the best experimental variety tested, and was not significantly different from the highest yielding entry at Logan. The old US22/3 variety was among the lowest yielding varieties in the tests demonstrated that good progress has been made since this variety was used as a commercial.

Table 1. Root yield, sugar percentage and quality factors for commercial and experimental hybrids at Farmington, Utah, 1979.

Variety	Gr. Sugar Lbs/Ac	Rt. Wt. Tons/Ac	% Sugar	N	Na	K	Index
GWRI	11,283	32.43	17.39	398	248	1633	515
GWD2	10,602	29.33	18.01	380	203	1677	484
Monoricca	10,573	29.59	17.83	337	436	1422	472
ACH31	10,286	30.66	16.77	299	454	1308	471
USH20	10,190	30.19	16.89	300	361	1270	441
AH10	10,056	30.35	16.58	334	297	1687	520
Bush Monofort	9,825	28.63	17.17	287	519	1543	502
UI8	9,744	28.60	17.01	307	298	1347	440
USH10B	9,439	29.31	16.12	343	293	1918	574
41F20+a	9,346	27.12	17.22	326	448	1685	527
ACH 130	9,307	28.34	16.40	293	490	1581	524
Beta 1345	9,185	26.57	17.26	405	349	1727	555
41F1+a	9,152	27.85	16.48	369	403	1712	575
HH7	9,012	26.70	16.81	312	353	1406	473
41F23+a	8,984	26.23	17.12	409	283	1697	545
AH12	8,995	27.56	16.31	278	325	1308	440
HH22	8,863	28.50	15.55	314	281	1752	551
HH28	8,841	26.88	16.45	440	307	1708	595
53.19	8,705	24.23	17.93	467	288	1595	542
G239	8,673	27.48	15.83	483	526	2104	759
Ultramono	8,640	25.66	16.85	452	426	1593	599
35E1	8,246	24.46	16.87	358	303	1681	527
US22/3	7,091	21.41	16.64	358	378	1616	538
46G1	6,909	19.54	17.69	366	253	1731	503
F	6.57	7.53	3.83	1.89	8.98	8.53	3.08
LSD	1106.84	2.95	.90	121.00	83.54	188.11	107.70
CV	10.47	9.41	4.67	29.45	20.56	10.20	17.82
Mean	9,248	27.40	16.89	359	356	1613	529

Table 2. Root yield, sugar percentage and quality factors for commercial and experimental hybrids at Logan, Utah, 1979.

Variety	Gr. Sugar Lbs/Ac	Rt. Wt. Tons/AC	% Sugar	N	Na	K	Index
Bush Monfort	5,035	14.51	17.44	341	298	1718	503
Monoricca	4,964	14.04	17.65	366	351	1695	516
USH20	4,847	14.90	16.21	486	335	1514	607
Beta 1237	4,702	12.97	18.12	397	204	1641	487
Ultramono	4,624	12.27	18.80	280	225	1618	407
HH28	4,597	14.51	15.88	394	195	1743	567
G239	4,573	13.88	16.45	533	330	1972	696
GWD2	4,539	13.55	16.78	444	186	1733	563
ACH31	4,531	13.26	17.12	377	313	1497	505
9.19	4,515	13.21	17.12	483	231	2010	629
HH22	4,319	13.31	16.19	412	175	1858	581
41F23+a	4,292	12.14	17.63	431	196	1814	541
ACH130	4,274	12.50	17.06	393	283	1756	549
USH10B	4,266	13.10	16.27	400	173	1879	571
GWR1	4,174	12.17	17.10	405	166	1560	502
AH10	4,108	12.09	16.98	344	123	1606	463
L53XL37	4,063	12.30	16.56	635	176	1789	692
41F21+a	4,055	12.14	16.71	510	235	1658	604
35.E1	3,935	11.51	17.06	453	239	1795	579
41F20+a	3,849	11.23	17.07	420	239	1581	527
U18	3,812	11.44	16.68	407	220	1462	514
HH7	3,745	11.83	15.88	466	249	1702	616
AH12	3,503	10.65	16.54	422	243	1420	523
46G1	3,491	9.25	18.91	391	150	1610	449
US22/3	3,422	10.24	16.73	436	214	1577	547
F	2.05	2.39	6.53	3.06	4.53	2.22	2.89
LSD	884.17	2.49	.85	112.61	79.28	283.54	113.23
CV	18.20	17.41	4.39	23.15	30.09	14.69	18.02
Mean	4,249	12.52	17.00	425	230	1689	549.58

B. FIELD TEST - NEW LINES

Several new lines have come out of our breeding methods program. The most promising were field tested at Farmington, Utah, with some of the best commercial hybrids (Table 3). All are open pollinated, self-sterile, multigerm lines. All came out of broadbase composite populations except g232 which was a hypocotyl diameter selection.

The new lines yielded equal to the hybrids; however, g237 had a significantly larger yield than UI8 and AH12. Most of the new lines were a little low in sugar, notably was the hypocotyl selection which had a good yield but was significantly low in sucrose percentage. In more cases the new lines were higher than the hybrids in potassium, sodium, and index.

Line g237 was also tested in 1977 and 1978 with the same hybrids. The results of these tests (two locations and two years) are summarized in Table 4. In these tests the open-pollinated selection (g237) performed equal to or better than UI8 and AH10, but below GWD2.

These new lines will be crossed to CMS testers in the summer of 1980 to test their combining ability.

Table 3. Mean root yield, sucrose percentage, gross sugar and impurity data for several new open-pollinated lines and commercial hybrids.

	Root Weight Tons/Acre	% Sugar	Gross Sugar Lbs/Acre	Nitrate ppm	Potassium ppm	Sodium ppm	Index
g237	32.72	16.38	10691	445	1995	464	679
GWD2	32.48	17.09	11107	448	1677	196	548
g239	29.20	16.16	9418	394	2218	427	683
g232	29.00	15.64	9097	480	2200	496	779
U18	28.97	16.64	9639	392	1468	318	525
AH12	28.11	16.86	9477	363	1500	263	493
g242	26.86	16.27	8745	608	2427	516	862
h532	26.91	15.39	8267	355	2031	603	700
US22/3	23.84	16.44	7832	323	1589	341	512
LSD(0.05)	3.54	0.71	1194	83	197	107	89
F	6.36	5.02	4.70	8.74	25.8	12.4	17.2
CV (%)	10.5	3.7	10.9	16.7	8.9	22.8	11.9

Table 4. Mean root weight, sucrose percentages and gross sugar for g237 (op line) and 3 commercial hybrids. Data are the mean of four tests conducted in 1977 and 1978.

	Root Weight Tons/Acre	% Sugar	Gross Sugar Lbs/Acre
GWD2	26.9	16.0	8600
g237	24.7	15.7	7755
U18	24.7	15.8	7800
Ah10	23.8	15.4	7330

C. SWEET SORGHUM VARIETY TRIAL

D. L. DONEY

Sweet sorghum has been suggested as a potential crop for alcohol fuel production. This test was to evaluate its potential in the intermountain area. Seed was obtained from Kelly C. Freeman, Meridian, Miss. Two 120-day varieties were tested (Dale and Keller). Keller is a new high-sucrose variety. Plots were four 30-foot rows with 32 inches between rows and replicated six times. Planting and harvest dates were June 5 and October 5, respectively. The trial was irrigated weekly by furrow. Thirty pounds N and 36 pounds P were broadcast prior to planting. An additional 30 pounds N and 36 pounds P were sidedressed July 20. The initiation of the panicle did not occur until early in September when the days were 12 hours or less. Keller was about five days behind Dale in flowering. Most plants were in the soft-dough stage at the October 5 harvest date. Maximum heights were 12 feet for Keller and 10.5 feet for Dale. Some mildew was observed midway through the growing season. There was a fairly heavy infestation of green peach aphid at harvest time. These were attracted to the ruptured cells on the underside of the leaves caused by an unknown disease.

Yields are given in Table 1. Keller was superior to Dale in both stalk and leaf yields with 20.9 and 4.1 tons per acre, respectively. Keller also had higher dry weight percentages. The dry weight yields for Keller were 2.3 and 5.3 tons per acre for leaves and stalks. A complete sugar analysis is unavailable at this time. However, preliminary analysis for Keller indicate: sucrose 10%, glucose 2.1%, and fructose 0.5%, for a total of 12.6% fermentable sugars.

Table 1. Fresh weight, % dry weight and dry weight for leaves and stalks of Dale and Keller sweet sorghum.

	Fresh Weight		% Dry Weight		Dry Weight		
	Leaves	Stalks	Leaves	Stalks	Leaves	Stalks	Total
Dale	3.4	17.9	54.4	21.7	1.9	3.9	5.8
Keller	4.1	20.9	56.1	25.1	2.3	5.3	7.6
LSD	0.5	3.6	3.4	1.9			

It should be noted that sugarbeet variety trials planted in the same field received 150 lbs N per acre and yielded between 25 and 30 tons per acre with a 16 percent sucrose content.

II. SELECTION METHODS

MATURE ROOT SELECTION FOR TAP-ROOT LEAF-WEIGHT RATIO AND ROOT SIZE

J. C. Theurer

In 1978, Snyder and Carlson (1) reported results of selecting superior genotypes for breeding based upon the ratio of the tap root to leaf blade-fresh weight ratio (TLWR). They concluded that differential partitioning of photosynthate occurs early in the plant and that these differences are maintained throughout the growing season. They felt that independent selection could be made for root size and root-leaf ratio since there was a relatively poor correlation between root weight and TLWR. They pointed out that breeders in the past focused attention on tap root weight alone at the end of the growing season and failed to recognize differences in partitioning and its effect on economic root yield.

MATERIALS AND METHODS

In 1978 a large selection block of each of two highly heterogeneous populations was planted at the Utah State University Evan's Farm near Logan. In the latter part of September all competitive beets were harvested and separated into leaf-blade, petiole, and tap-root components. Weight of each component was obtained and the TLWR ratio was calculated. All roots with weight exceeding the mean of the population were evaluated for specific gravity (an indication of sucrose content) using a salt solution.

Seed increases were made of several different selection groups listed in Table 1. Selections exceeded at least one standard deviation for each factor used as a selection criterion. The selections were planted in 1979 in a field trial in six replications at standard 22" row width with 12" between plants within the row. Due to poor stand explained previously (see commercial variety tests in this report), the experiment was replanted June 7, 1979, and harvested October 16, 1979. This resulted in a short growth season of only 130 days and resulted in lower root yields than we would expect during a normal growth season. However, the comparison of selections with their parent population should be similar regardless of the length of the growth period.

RESULTS

The results of this experiment are shown in Table 1.

Selection for large roots and high root-leaf ratios was not effective in increasing yield in either population. Selection #3 from population 35F2 had significantly higher root yield and gross sugar than the parent population. This selection was made on the basis of plants with large roots and large tops at harvest. The parent 6F2 had significantly greater yield than every selection made from this population. We note, however, that the selection for high root weight and large tops was the selection with the highest yield in this population also. There was no change in sucrose percent between the parents and the selections in either population.

The 6F2 population was previously tested for TLWR in the seedling stage at Logan and at Beltsville (By Dr. F. W. Snyder). There was highly significant variation between plants in the population.. Therefore, TLWR selection should have been effective.

Based on data from this test we would conclude that selection for TLWR at harvest is not an effective means of improving root yield. Either differences in TLWR are not carried through until harvest or TLWR is not an effective means of selection for some genotypes.

Table 1. Yield, sucrose percentages and quality factors for mature sugarbeet root selections, Logan, Ut, 1979

Selection	Gross Sugar Lbs	Root Yield T/AC	% Sucrose	Amino N ppm	NA ppm	K ppm	Impurity Index
35-F2 Parent	4055	12.59	16.10	411	255	1672	572
Selection #1 LR(1),R/T(2)[1/]	3912	11.84	16.56	379	256	1757	551
Selection #2 LR(1),R/T(1)	4307	12.87	16.74	520	225	1555	593
Selection #3 LR(1),LT(1),R/T($\overline{X}$)	4553	14.11	16.17	481	337	1952	676
Mean	4207	12.86	16.39	448	268	1734	598
CV	5.51	7.14	5.12	13.96	21.31	12.61	11.31
LSD.05	320	1.26	1.16	86.27	78.87	301.44	93.29
6F2 Parent	5526	16.43	16.82	449	254	1827	595
Selection #1 LR(1),R/T(1)	3292	9.31	17.62	427	137	1572	495
Selection #2 LR(1),LT(1),R/T(1)	4236	12.11	17.44	466	227	1412	523
Selection #3 LR(1)	4101	11.40	17.95	332	166	1375	412
Selection #4 LR(1),Sp. Gr. (1)	3815	10.74	17.77	383	167	1195	417
Mean	4193	12.00	17.52	412	190	1476	489
CV	14.58	11.59	5.56	22.35	21.89	12.58	21.54
LSD.05	820	1.87	1.31	123	107	249	141

[1/] LR = Large Root, LT = Large Top, R/T = Tap/Root - Leaf/Weight Ratio, (1) selection exceeded 1 standard deviation, (2) selection exceeded 2 standard deviations, ($\overline{X}$) selection exceeded the mean.

III. PHYSIOLOGICAL GENETICS

D. L. Doney

Increased root yields of sugarbeet have generally been accompanied by decreases in sucrose percentage. Plant breeders have been unable to break this negative relationship. A knowledge of the physiology of this negative relationship would give the plant breeders a foundation from which to develop more effective breeding methods. Last year (Sugarbeet Research, 1978) we reported on the effects of cell size and cell division rate on root yield and sucrose percentage. Genetic differences in root yield are due to genetic differences in cell size. The negative relationship between yield and sucrose percentage is due to the opposite effects of cell size on root yield and sucrose percentage; i.e., large-celled genotypes have larger roots and are low in sucrose concentration, whereas small-celled genotypes have small roots and are high in sucrose concentration.

We have pursued this theory more extensively this past year to include genetic and heterosis studies.

A series of seven tests were conducted in this investigation. All cell-size and cell-division rate studies were conducted in the greenhouse. Cell size and cell-division rate were determined microscopically from stained root-cross sections of sugarbeet seedlings. Root yield and percent sucrose data were obtained from replicated field trials.

The first two tests were to confirm the cell-size and cell-division rate relationships developed last year.

Test 1

Fourteen cultivars grown in a replicated field trial in 1978 were grown in the greenhouse and the mean cell size determined at 21 days (Table 1). A highly significant correlation of -0.85 was obtained between sugar percentage and mean cell size. The high-sugar line had the smallest cells, (almost twice the low-sugar line). There were some deviations; however, most fit the regression line fairly well.

Test 2

Two females (L53 and L33) crossed to the same six males were tested in the field and in the greenhouse. Data were recorded for root yield, percent sucrose from the field, mean cell size, mean cell number (radius of cross-section) number of rings, ring width, and cells per ring from the greenhouse test. Table 2 gives these data summed over the six males.

The L53 hybrids significantly outyielded the L33 hybrids but were no different in sugar percentage (Table 2). This increase in yield was due to an increase in cell number (cell division rate) and not cell size. There were more cells per ring causing the rings to be wider but no difference in ring number. This substantiates our earlier tests. Since there was no difference in the

sugar percentage, cell size should not be different. Differences in yield should, therefore, be due to differences in cell division rate, which was the observed result.

Table 1. Correlation of sugar percentage and mean cell size for fourteen cultivars.

Cultivar	Sugar %	Cell Size CM^3X10^{-8}
L19	19.0	2.39
46F3	18.1	2.50
L53	17.0	2.98
28F1	17.0	3.13
6F4	16.9	2.96
Beta 1345	16.7	3.76
g242	16.3	3.45
AH12	16.3	3.99
AH10	16.2	3.94
UI#8	16.1	4.23
USU20	15.6	3.66
UL51	15.5	3.87
L37	15.0	4.03
g1	14.9	4.44
LSD (0.05)	0.7	0.73

r = -0.85

Table 2. Root yield, percent sugar, cell size, cell number, ring number, ring width, and cells per ring for L53 and L33 crossed to the same six males. Data are summed over males.

Female Parent	Root Yield T/A	% Sugar	Cell Size CM^3X10^{-8}	Cell Number Cells/Radius	Rings	Ring Width CM	Cells/ Ring No.
L53	27.7	15.5	4.17	50.0	2.53	1.73	19.65
L33	24.3	15.5	4.22	46.0	2.50	1.63	18.50
Difference	3.3	0.0	0.05	4.0	0.03	0.10	1.15
LSD.05	1.0	0.3	0.49	2.7	0.035	0.08	1.00

Test 3

In Test 3, four L29 hybrids and inbred parents were tested in the field and in the greenhouse (21 days old). The four male parents differed widely in their combining ability for yield and sugar percentage (Table 3). Cell size was inversely correlated with percent sugar, i.e., the high sugar hybrid had

the smallest cells and the low-sugar hybrid had the largest cells. There was also a positive correlation of root yield and cell number; however, cell size also effects root yield and tends to confound this correlation.

Table 3. Sugar percentage, cell size, root yield and cell number for four L29 hybrids.

	Sugar	Cell Size	Root Yield	Cells
	%	CM^3X10^{-9}	T/A	Radius/21 Days
L29 X L19	18.7	6.89	24.5	75.7
L29 X L53	15.8	6.95	27.5	84.0
L29 X L35	15.7	7.02	22.2	73.6
L29 X L38	14.2	7.04	27.9	78.6
LSD (0.05)	0.8	0.92	4.6	5.0

Heterosis (greater than mid-parent) was calculated for root yield, cell number, sugar percent and cell size (Table 4). Highly significant heterotic effects were obtained for root yield and cell number. The size of the heterotic effect for root yield was highly correlated with the size of the heterotic effect for cell number (Table 4). We seldom observe heterosis for sugar and in this test the only hybrid to approach significant heterosis was L29 X L35 (Table 4). For cell size, hybrid L29 X L53 exhibited significant heterosis and L29 X L38 approached it while the other two were non-significant. These data strongly suggest that root yield heterosis is due to cell division rate heterosis and not cell size. It also suggests that cell size is determined by additive gene effects and cell division rate is affected by non-additive gene effects.

Table 4. Heterosis (greater than mid-parent) for root yield, cell number, sugar percentage and cell size of the four L29 hybrids.

	Yield	Cells	Sugar	Cell Size
	T/A	Radius/21 Days	%	CM^3X10^{-9}
L29 X L53	15.7	13.70	-0.10	1.21
L29 X L38	13.2	10.00	0.51	0.89
L29 X L19	8.5	9.28	0.11	0.65
L29 X L35	6.9	3.64	0.70	0.77
For Significance (0.05)	4.7	4.28	0.71	0.90

Test 4

This test was very similar to Test 3. Four male inbred lines were crossed

to L29 and tested in the field and in the greenhouse (inbred parents and F1 Hybrids). Greenhouse data was on 21-day-old plants.

Cell division rate (cell number, Table 5) was correlated with root yield. Differences in sugar concentration was not as great as in Test 3; however, cell size tended to correlate inversely with sugar concentration except for hybrid L29 X L21. This hybrid had an unusually small cell size and did not fit the pattern of all previous data. It even gave a significant negative heterotic value for cell size (Table 6).

Table 5. Root yield, cell number, sugar percentage, cell size and potential volume for four hybrids.

	Root Yield	Cell Number	Sugar	Cell Size	Relative Volume
	T/A	Cells/Radius	%	CM^3X10^{-9}	Cell X Cell Size
L29 X L53	20.8	90.2	15.6	5.80	523
L29 X L21	20.2	83.9	15.7	4.30	361
L29 X L19	18.5	91.9	16.7	5.00	461
L29 X L35	16.8	78.7	16.0	5.00	393
LSD (0.05)	2.1	6.7	0.7	.92	

Heterosis for cell division rate (cell number) was correlated with heterosis for root yield (Table 6). Neither sugar concentration nor cell size gave significant heterosis except hybrid L29 X L21 as previously mentioned.

These data again suggest that heterosis is due to differences in cell division rate rather than cell size.

Table 6. Heterosis for root yield, cell numbers, sugar percentage and cell size of four hybrids.

	Root Yield	Cell Number	Sugar	Cell Size
	T/A	Cells/Radius	%	CM^3X10^{-9}
L29 X L53	7.7	14.5	0.17	0.73
L29 X L21	6.0	13.5	0.37	-1.20
L29 X L19	3.8	11.1	0.29	0.00
L29 X L35	3.2	1.2	0.83	0.02
For Significance	(0.05)			
	2.0	6.7	0.70	0.92

Test 5

This test was designed to measure combining ability for cell size and cell

division rate. The test material was crossed to form a 5 X 5 diallel and included the inbred parents. Testing was conducted on greenhouse grown 21-day-old plants. No field data were available. The parent means and hybrids means differed significantly for cell size (Table 7). When heterosis was summed over hybrids for each line, only one line gave a significant heterosis effect for cell size.

Table 7. Cell size (CM^3X10^{-9}) for 5 X 5 diallel and mean heterosis for each line.

	A4	A5	F4	F6	E1	Mean	Mean Heterosis
A4	7.11	8.34	10.15	8.63	7.76	8.40	0.21
A5		11.08	13.49	11.88	9.15	10.79	0.58
F4			11.72	11.97	10.73	11.61	1.34
F6				10.15	9.92	10.51	0.94
E1					6.70	8.85	1.03
LSD (0.05)						1.06	
For Signi-ficance	(0.05)						1.45

Cell division rate (cell number) gave different results. There were differences in cell numbers between inbred parents and between hybrid means but differences were smaller than for cell size (Table 8). However, highly significant mean heterosis effects were observed for each parent in cell division rate (cell number). There were also differences between parents for mean heterosis of cell number.

Table 8. Cell number (cells across radius of cross section) for 5 X 5 diallel and mean heterosis for each line.

	A4	A5	F4	F6	E1	Mean	Mean Heterosis
A4	76.6	99.5	108.5	104.7	93.3	96.5	22.01
A5		85.3	97.8	101.9	102.5	97.4	17.71
F4			85.6	95.1	92.1	95.8	15.51
F6				87.0	92.1	96.2	15.10
E1					71.6	90.3	17.39
LSD (0.05)						3.1	
For Significance		(0.05)					3.55

General and specific combining ability was analyzed for both cell number (cell division rate) and cell size (Table 9). The relative proportion of the total genetic variance connected to the two combining abilities was reversed

for these two characters, i.e., genetic differences for cell number were largely due to specific combining ability (SCA) effects whereas genetal combining ability (GCA) effects were the major contributors to genetic differences in cell size (Table 9). Since GCA effects are largely due to additive gene action and SCA effects reflect non-additive gene action, we can conclude that cell size is affected by additive genes and cell division rate (cell number) by non-additive genes.

Table 9. General (GCA) and specific (GCA) combining ability of 5 X 5 diallel for cell number and cell size.

	Cell Number			Cell Size	
	df	ms	f	ms	f
GCA	4	55.59	7.88**	.1169	37.01**
SCA	10	127.25	18.05**	.0070	2.23NS
Error	510	7.05		.0031	

** = Significant at p = 0.01

Tests of 6 and 7

Cell size and cell division rate (cell number) were measured in a 3 X 3 males times females cross at 15 (test 6) and 25 (test 7) days of age. The effects of each line summed over its crosses is given in Table 10. There were differences between lines for both cell size and cell division rate (cell number). Lines used as males had greater differences for cell division rate (cell number) than the lines used as females, whereas the female lines showed greater differences for cell size than the male lines. There was good agreement in ranking for the two dates of harvest (ages).

Table 10. The effects of each line of a 3 X 3 males lines females cross on cell size and cell division rate (cell number) at 15 and 25 days of age.

	Cell Size CM^3X10^{-8}		Cell Number Cells/Radius	
Males	15 day	25 day	15 day	25 day
L19	3.97	5.72	38.3	96.0
L37	4.03	5.96	37.7	89.6
L35	4.05	6.36	36.5	95.3
LSD 0.05	.55	.45	2.0	4.3
Females				
L53	3.85	6.24	38.6	94.6
A4	3.10	4.87	36.1	94.8
A7112	5.03	6.82	37.7	91.1
LSD 0.05	.55	.45	2.0	4.3

General combining ability was the main effect (highly significant) for cell size at both ages (Table 11). There was no significant specific combining ability for cell size. Significant general and specific combining ability was obtained for cell division rate (cell number) at both ages (Table 11). Specific combining ability was more important for cell number than general combining ability.

Table 11. F ratios for general and specific combining ability for cell size and cell division rate (cell number) of a 3 X 3 males times females cross at 15 and 25 days of age.

	Cell Size CM^3X10^{-8}		Cells Number Cells/Radius	
	15 day	25 day	15 day	25 day
GCA	22.10^{xx}	34.6^{xx}	4.31^{xx}	6.44^{xx}
SCA	2.02 ns	1.1 ns	6.00^{xx}	5.05^{xx}

xx = Significant at p = 0.01

From this data estimates were made for additive and non-additive genetic variance (Table 12). Additive genetic variance accounted for 79 and 91 percent respectively of the total genetic variance for cell size. The opposite relationship was observed for cell-division rate, i.e., non-additive genetic variance accounted for 82 and 70 percent, respectively, of the total genetic variance for cell number.

Table 12. Variance estimates and percentages of total genetic variance of additive and non-additive effects for cell size and cell division rate (cell number) at 15 and 25 days of age.

	Cell Size (CM^3X10^{-8})				Cell Number (Cells/Radius)			
	15 Day		25 Day		15 Day		25 Day	
	V	% of Total	V	% of Total	V	% of Total	V	% of Total
Additive	1.05	79	1.05	91	2.35	18	17.01	30
Non-Additive	0.28	21	0.10	9	10.81	82	39.02	70

V = Variance

These results suggest the following conclusions:

1. Differences in percent sugar are largely due to differences in cell size.

2. Differences in root yield are due to genetic differences in both cell size and cell division rate.

3. The negative correlation between root yield and percent sugar is due to the inverse effect of cell size on root yield and percent sugar.

4. Cell size is largely conditioned by additive type genes.

5. Differences in cell division rate are due to non-additive genes.

6. Heterosis is due to increases in cell division rate and not to increases in cell size.

IV. GROWTH ANALYSIS

A. GENOTYPE TIMES PLANT DENSITY

D. L. Doney

Past plant density studies in sugarbeet have largely been within row-density investigations. Using current sugarbeet hybrids, very little effect is observed between stand densities of from six inches to 18 inches in the row. Increases in yields have been obtained by decreasing row-width from 30 inches to 22 inches. Row width of at least 22 inches is essential for the present mechanization of sugarbeet, i.e., tractors, planters, harvesters, etc. Therefore, there has been little reason for investigating row width of less than 22 inches.

If significantly higher yields could be achieved at narrower row widths, the mechanization could be adopted to fit it. In addition, if fodder beet is to be used as a fuel crop on a large scale, new harvesting methods and equipment need to be developed that could be effective on narrower rows.

Breeding over the past thirty years has been for vigorous hybrids. The vigor of these hybrids has been sufficient to adjust and compensate for within row distances of up to 18 inches between beets. Less vigorous inbreds cannot compensate for such wide distances, and under our present practice of 22-inch rows, always yield less than the hybrids.

This study was designed to answer the following questions:

1. Since present hybrids will not compensate for distances greater than 18 inches, can we increase hybrid yields by decreasing row widths below 22 inches?

2. Will less vigorous inbreds equal hybrid yields at closer row widths?

3. Can we increase total sugar production by growing high-sugar inbreds at narrow row widths?

METHODS AND MATERIALS

The following hybrid and inbreds were selected for testing:

GWD2 = Very vigorous hybrid, med sugar.
C17 = Vigorous inbred, low sugar.
L10 = Small top, large root inbred, med-low sugar.
L19 = Large top, small root inbred, high sugar.

Row widths were 12 and 24 inches. Plots were eight and four rows for the 12 and 24-inch row widths, respectively, replicated six times. The center four rows of the 12-inch and center two rows of the 24-inch width were harvested. Harvesting and topping were by hand. Data taken were root and top fresh and

dry weights, sugar percent, plant density and impurities.

RESULTS

All data taken were affected by row spacing (Table 1). Highly significant increases in yield (gross sugar, root fresh yield, root dry yield, leaf dry yield and non-sugar dry yield) and percent dry weight (root % dry weight, leaf % dry weight, non-sugar % dry weight and % sugar) were obtained at the 12-inch over the 24-inch row spacing. Quality factors, (nitrogen, potassium, sodium and index) were lower at the 12-inch row spacing.

Table 1. All data summed over varieties for 12 and 24-inch row spacings.

	Row Spacing		
	12 Inch	24 Inch	LSD.05
Gross Sugar (Lb/A)	9390	7615	329
Root Fresh Yield (T/A)	28.13	23.48	0.91
Percent Sugar	16.81	16.29	0.35
Root % Dry Weight	22.44	21.44	0.62
Leaf % Dry Weight	15.70	15.25	1.00
Root Dry Yield (T/A)	6.27	5.02	0.22
Leaf Dry Yield (T/A)	2.64	1.89	0.17
% Dry Weight (Non-Sucrose)	5.63	5.14	0.26
Dry Yield - Non Sugar (T/A)	1.58	1.19	0.11
Nitrogen (PPM)	415	491	36
Potassium (PPM)	1693	1897	108
Sodium (PPM)	281	341	29
Index	562	670	38
Plant Density (Plants/A)	46911	19806	1116

There were significant differences between varieties for all measured characters except index.

There were significant spacing x variety interactions for all quality factors (nitrogen, sodium, potassium, and index). In each of these measurements, lines L10, L19 and GWD2 were significantly lower at the 12-inch row width, whereas line C17 was only slightly but non-significantly lower. This different reaction of C17 (row-width) to the other lines caused the significant interactions.

The only other significant interactions were for root yield and gross sugar (Table 2). The interaction for percent sugar was very close to significant. GWD2 (a vigorous hybrid) increased in root yield less at the narrower row width than the less vigorous inbreds resulting in the significant interaction for root yield. There appeared to be a regression of row width effect on vigor, i.e., the less vigorous the genotype the greater increase in root yield at 12-inch over the 24-inch row width.

Table 2. Data for each genotype at the 12-inch and 24-inch row width.

Measurement	Row Width	Genotype L10	L19	C17	GWD2	LSD 0.05
Rt Yield (T/A)	12"	29.55	23.67	27.82	31.49	1.83
	24"	22.48	18.32	23.62	29.50	
% Sugar	12"	15.70	19.00	15.55	17.00	0.70
	24"	15.05	18.25	15.11	16.75	
Gross Sugar (Lbs/A)	12"	9279	8995	8652	10707	657
	24"	6766	6687	7138	9882	
Rt % Dry Weight	12"	20.65	25.76	20.66	22.68	0.76
	24"	19.75	24.63	19.54	21.82	
Rt-Dry Yield (T/A)	12"	6.10	6.10	5.75	7.14	0.43
	24"	4.43	4.51	4.60	6.43	
% Non-Sucrose Dry Weight	12"	4.99	6.76	5.11	5.68	0.60
	24"	4.70	6.38	4.41	5.07	
Non-Sucrose Dry Yield (T/A)	12"	1.48	1.60	1.43	1.80	0.22
	24"	1.06	1.17	1.03	1.49	
Leaves-Dry Yield (T/A)	12"	2.16	2.86	2.61	2.91	0.43
	24"	1.38	2.12	1.85	2.23	
R/S Ratio (dry)	12"	2.82	2.13	2.20	2.45	
	24"	3.21	2.13	2.49	2.88	

Sugar concentration tended to follow this same regression; however, differences were not as large resulting in a non-significant interaction. This increase in the row width effect of the less vigorous genotype for root yield and percent sugar resulted in a significant gross-sugar interaction.

Not only were the root yield, percent sugar, and gross sugar increased at the narrower row width, but significant increases were also obtained for percent non-sucrose dry matter (Table 2).

Twelve-inch row width increased top yields more than root yields resulting in a significant change of the root/shoot ratio.

These results suggest several conclusions:

1. Increases in yield can be obtained at narrower row widths than the standard 22-inch width with our present vigorous hybrids.

2. Inbreds tested at the standard width have insufficient vigor to effectively utilize all the space available.

3. Yields equal to our best hybrids can be obtained from some inbreds if grown at their optimum (narrower) row width. (Note L10 at 12 inches versus GWD2 at 24 inches).

4. The partitioning of the photosynthesis may be the important factor for increasing yields at narrow row width. The L10 genotype has a large root and small top (R/S ratio, Table 2), and showed a greater increase than the L19 genotype which has a large top and small root (R/S ratio, Table 2).

5. Narrower row widths will result in increases of both sugar and pulp yields.

B. PARTITIONING OF PHOTOSYNTHATE TO COMPONENT PARTS OF SUGARBEET PLANTS

J. C. Theurer

The sugarbeet plant can be separated into four component parts: the blades, petiole, tap root, and fibrous root. During the first few weeks of ontogeny, the petioles and blades are the dominant sinks. Subsequently, most of the photosynthate produced in leaves is transported to the root, the important economic part of the plant. Snyder and Carlson (1) found that their selections for high and low tap-root/leaf-blade weight ratio also differed in the amount of dry matter in the tap root versus the amount in the fibrous roots. They suggested that the difference between high and low-yielding varieties might be the difference in their partitioning to tap root versus fibrous roots. It would be impossible to try to determine the amount of fibrous roots versus tap roots under field conditions. This is evident because of the difficulty of harvesting the fibrous root portion; however, under greenhouse conditions, for a short period of time, one can recover the fibrous roots as well as the tap root and make a comparison between varieties. In 1979 we studied the dry matter partitioning to blades, petioles, tap roots and fibrous roots for six varieties that differed greatly in their root yield and sucrose content at harvest. These varieties are listed in the first column of Table I. GW-D2 and UI-8 are high-yield commercial varieties. Blanca is a fodder beet having high yield but low sucrose content. L53 x L37 is an experimental yield type hybrid. L53 x L19 is a high-sugar content hybrid, and EL40 is the line that was used by Snyder and Carlson (1) in their selection studies.

Table 1. Fresh weight of blade, petiole, tap root, and fibrous root for sugarbeet genotypes after 40 days growth in greenhouse

Variety	Blade F.W. gm	Petiole F.W. gm	Tap Root F.W. gm	Fibrous Root F.W. gm	Total F.W. gm
GW-D2	9.94 a[1/]	5.12 a	.99 ab	1.92 a	18.03 a
UI-8	9.12 a	4.99 a	.91 b	1.72 ab	16.95 a
Blanca	8.28 a	5.08 a	.77 b	1.86 a	15.99 a
L53XL37	9.38 a	4.79 a	1.27 a	1.69 ab	17.15 a
L53XL19	9.58 a	5.56 a	.99 ab	1.96 a	18.07 a
EL40	6.36 b	2.81 b	.72 b	1.32 b	11.22 b
Mean	8.78	4.73	.94	1.74	16.23
LSD.05	1.83	1.26	.28	.42	3.72

[1/] Duncan's multiple range test. Means having the same letter are not significantly different at the 5% level.

These varieties were seeded into the fine washed white sand in six-inch pots inserted into a sand bench in the greenhouse. Care was made to seed plants at the same depth, with the same amount of sand covering the seed. Two days

after emergence the plants were thinned to a single plant per pot. Each pot was watered daily with 50 ml of a complete nutrient solution. Plants were rotated twice weekly from front to rear and left to right in the bench. They were grown under constant gro-lux lighting. After 40 days growth the leaves of petioles were trimmed from the roots and weighed. The sand was washed away from the roots, and subsequently the fibrous roots were separated from the tap root. The roots were blotted dry of all free moisture and weighed for a fresh weight. All component parts were dried in a 100°F. oven and weighed to determine dry matter. Each variety was represented by 17 plants in a run and five repeated runs of the experiment were made.

Table 2. Dry matter of blade, petiole, tap root, and fibrous root for sugarbeet genotypes after 40 days growth in greenhouse.

Variety	Blade D.M. gm	Petiole D.M. gm	Tap Root D.M. gm	Fibrous Root D.M. gm	Total D.M. gm
GW-D2	.78 ab	.27 ab	.10 ab	.27 ab	1.43 ab
UI-8	.72 ab	.29 a	.10 ab	.27 ab	1.40 ab
Blanca	.62 b	.26 ab	.07 c	.27 ab	1.21 ab
L53XL37	.74 ab	.26 a	.14 a	.25 ab	1.38 ab
L53XL19	.82 a	.32 a	.11 ab	.31 a	1.56 a
EL40	.63 b	.18 b	.08 bc	.24 b	1.13 b
Mean	.72	.26	.10	.27	1.35
LSD.05	.17	.07	.03	.07	.32

RESULTS

The fresh weight of the blades, petioles, tap root, and fibrous roots are given in Table 1. With the exception of the EL40 variety, there were few differences in fresh weights. Dry matter of the component parts for each variety are listed in Table 2. L53 X L19 produced the greatest amount of dry matter in 40 days and EL40 the least. L53 X L19 also had the largest amount of dry matter in the blades and Blanca and EL40 had the smallest amount of dry matter for blades. With the exception of EL40, the varieties didn't differ markedly in petiole and fibrous root dry matter. L53 X L37 was highest and Blanca and EL40 were lowest in tap root dry matter.

On the average, 54% of the total dry matter of the plant was in the leaf blades at 40 days growth (Table 3). About 19% was found in the petioles and fibrous roots and only 7% in the tap root at this stage of development. GW-D2 and EL40 had the greatest percentage of dry matter in the blades and Blanca had the least. UI-8, Blanca, and L53 X L19 had high petiole percent dry matter. L53 X L37 had significantly the greatest, and Blanca had significantly the lowest percent of dry matter in the tap root. Blanca and EL40 proportioned a significantly greater percent of dry matter to the fibrous roots than the other entries. Of interest was the fact that the high dry matter in Blanca fibrous roots was offset by low dry matter in the tap root, while the high dry matter of fibrous roots for EL40 was offset by low petiole, rather than low root dry

matter.

Table 3. Percentage of total dry matter of blade, petiole, tap root, and fibrous root for sugarbeet genotypes after 40 days growth in greenhouse.

Variety	Blades D.M. %	Petiole D.M. %	Tap Root D.M. %	Fibrous Root D.M. %
GW-D2	55.6 a[1/]	19.0 b	6.8 b	18.6 b
UI-8	53.8 b	20.4 a	6.8 b	19.0 b
Blanca	51.8 c	21.0 a	5.2 c	22.2 a
L53 X L37	54.4 ab	18.4 b	9.4 a	18.0 b
L53 X L19	53.6 b	20.4 a	6.6 b	19.2 b
EL40	55.6 a	16.4 c	6.8 b	21.0 a
Mean	54.1	19.3	6.9	19.7
LSD.05	1.5	1.1	.9	1.4

[1/] See Table 1

The high-sugar hybrid, L53 X L19, had the greatest amount of total dry matter of the six entries; however, there was no difference in the way that this hybrid and the high-yield cultivars GWD2 and UI-8 partitioned dry matter to the plant parts.

Based on the above data we can conclude that varieties begin early to show differences in the total dry matter they produce and that they differ significantly in the percentage of dry matter they portion to the different component parts of the sugarbeet plant. There was no consistent difference noted for yield versus sugar type varieties. There was not a consistent relationship between the dry matter partitioned to the tap root versus the fibrous root. Thus the differences in partitioning can be ascribed to inherent differences of the individual genotypes.

C. SEASONAL GROWTH OF SUGARBEET GENOTYPES

J. C. Theurer

The seasonal growth response of sugarbeet varieties has been studied by several scientists. These studies have demonstrated that different cultivars have fairly similar growth patterns for root and top growth and sucrose accumulation (1). Most of the information on growth responses has resulted from the study of commercial cultivars. Only limited information is available concerning the growth rates and dry matter accumulation of highly diverse genotypes. During recent years, we have studied seasonal growth response of some sugarbeet hybrids and inbreds that differed for root weight and sucrose content in an attempt to discern parameters that could be used to identify high-yield or high sugar type beets.

In 1979 we studied the seasonal growth response, sucrose content, and dry matter accumulation of six highly diverse inbred sugarbeet lines. The lines were planted in eight replications of a random block design. There were eight subsets within each replicate for harvest on a 14-day basis during the growing season. Individual plots consisted of two rows, 20 feet long with beets 10-12 inches apart in the row. The first harvest was made on June 17 and subsequent harvests were made every two weeks thereafter. Ten competitive beets were dug from each plot in each replication. Separation was made of the leaf blades, petioles and roots. The petioles and leaf blades were weighed immediately. The roots were washed, air dried, and weighed shortly thereafter. Leaf areas were determined using a Lamda Area Meter. The petioles were chopped up and leaves and petioles were dried in a forced air dryer. Sucrose content was determined by the standard cold-digestion method. Prior to sampling the root for sucrose, a slice was cut just below the lower leaf scars of the beets, which slice was used to determine the root diameter, the number of vascular rings, and the width of the three innermost rings of the root.

RESULTS

Data for the final harvest for root yield sucrose percentage, root diameter, and length, and dry matter partitioning to the blade, petiole and tap root are shown in Table 1. There were highly significant differences between the genotypes for fresh and dry weights of roots. L10 had greater root weight than all other lines and yielded twice as much as L53 and L37. As expected from previous years research, L19 had the highest sucrose percentage. L37 and C17 were significantly low in sucrose. The latter two lines also were lowest in the percentage of sucrose in the total dry matter. The high root yield of L10 can be attributed to both larger diameter and longer roots than most other entries. The length of the root of L37 was almost equal to L10, but the diameter of this inbred was significantly less. The root measurements further substantiate our previous research at Logan, which shows that root diameter is highly correlated with root yield. L10 also produced the greatest quantity of dry matter, considering the whole plant. L19 and F6 were about equal and C17 only slightly lower in total plant dry matter.

Approximately 43% of the total dry matter on the average was partitioned to the top and 57% to the root. Of special significance was the manner in which the different lines partitioned dry matter. The dry matter of the tops of L19, our high-sugar inbred, exceeded the dry matter of the root. Contrariwise, approximately 64% of the total dry matter of L10 was found in the root.

Fig. 1a shows the fresh root weight and Fig. 1b the root dry matter of the six lines by harvest date. The seasonal growth for the most part follows the typical root growth curve for sugarbeets. The fresh weight and root dry matter curves were very similar. Inbred L10 shows a different response curve than the other entries. By the middle of August, this line exhibited a significantly faster root development.

Sucrose content of the lines is shown in Fig. 1c. The L19 inbred had a sucrose accumulation pattern similar to that observed in previous years studies. At early harvest this line had less sucrose than other high-sucrose lines, then increased at a more rapid rate than all other genotypes during the balance of the growth period. L37 and C17 were the low-sucrose content entries.

There were widespread differences in the number of living leaves at each harvest (Fig. 2a). The high-sugar inbred L19 had significantly the greatest number of leaves from harvest -2 to harvest -8. C17, a high-yielding inbred, was second in having a large number of leaves. Note in particular that the high-yield inbred L10 was one of the entries having the least number of living leaves at each harvest.

The genotypes with the greatest numbers of dead leaves were essentially those having the most living leaves (Fig. 2b).

L53 and L37 had significantly less leaf area than the four other inbreds in the test (Fig. 2c). The other four lines were similar in leaf area. The limitation of yield of L37 might be due to a small number and small size of leaves. L10, the highest yielding line, had a similar number of leaves to L37, but the leaves were of a large size. L19 had a luxuriance of leaves and consequently more photosynthate would be required for maintenance of the top rather than being transferred to the root for growth and sucrose accumulation.

Root diameter and root length are shown in Fig. 3a and 3b. L53 had the smallest roots and L10 the largest roots by each dimension measurement.

In general, the relationship of one line to another for root length was similar to that for root diameter, L37 inbred was an exception. This line has a long root but of relatively small root diameter (Fig. 3a and 3b). The highest yielding lines at each harvest date had both large root diameter and long root length.

The high-sugar line L19 had significantly more vascular rings than other genotypes at each harvest (Fig. 3c). The six entries segregated into two groups with respect to the width of the first three rings (from center core) (Fig. 3d) L10, C16, and F6, yield type lines, had significantly greater ring width than L37, L53, or L19 at each harvest. L37 is low in sucrose content and usually thought of as a yield type line. The narrow ring width of the L37 is an exception to the premise that narrow ring widths indicate greater sucrose content.

The total dry matter accumulation increased in a linear manner during the growth period (Fig. 4d). Differences between genotypes became more pronounced as the season advanced. L10 led all other varieties. When the total dry matter was partitioned into components of leaf blade, petiole, and root parts, we observed significant differences for the six genotypes (Fig. 4a, 4b, 4c). In general, the percentage of dry matter in the leaf blades decreased in a rapid curvilinear manner from harvest -1 to harvest -8 (Fig. 4a). Percentage of total dry matter in the petiole increased until the last harvest in August, then decreased slightly until harvest -8 (Fig. 4b). The dry matter percentage going into the root increased almost linearly. L10, L53, and L37 were similar in the percentage of total dry matter found in the root component. C17, L19, and F6 also had similar percentages of dry matter in the root at each harvest. There were significant differences between the two above groups in the percentage of dry matter that was partitioned to the root portion of the plant (Fig. 4c and Table 1). There was no association between sugar or yield type and the ability to accumulate a greater percentage of dry matter in the root as evidenced by the L19 (high sucrose) and C17 (high yield) type entries. (Fig. 4c).

DISCUSSION

This years study of the seasonal growth response of six divergent genotypes shows similar growth patterns to those observed in previous years. However, there are sufficient differences in sucrose types, yield types, lines that have either large or small canopies, etc, to indicate that it would be easy to draw some erroneous conclusions regarding sugarbeet growth, if one were to select only certain genotypes. While most genotypes studied in this experiment had similar rates of sucrose accumulation, L19 differed markedly (Fig. 1c). The L10 inbred showed a significantly different rate of increase in root yield compared to the other entries (Fig. 1a). Low-sugar genotypes do not always have wide vascular rings, and high-sugar genotypes, narrow rings (See L37, Fig. 3d and Table 1). The narrow rings of L37 are probably associated with its manner of cell division and cell enlargement relative to the long root growth habit of this line.

Root diameter still remains as one of the most reliable selection criteria for selecting high yield beets. (Fig. 3a) Root length is more difficult to measure and has less association with root yield (Fig. 3b) than root diameter.

REFERENCES

1. Theurer, J.C. 1979, Growth Patterns in Sugarbeet Production, J. Am. Soc. Sugarbeet Technol. 20: 343-367.

Table 1. Root yield, sucrose percentage, root diameter and length, and percentage of dry matter partitioned to blade petiole and root at October 18, 1979 harvest.

	Root Yield		Sucrose		Root		Dry Matter Partitioning			Total Dry
	F.W.	D.M.	F.W.	D.M.	Diameter	Length	Blade	Petiole	Root	Matter
Line	kg	gm	%	%	cm	dm	%	%	%	gm
L10	7.78	1.82	17.9	76	8.3	2.7	15.7	20.3	63.8	2.79
L19	3.95	1.09	20.7	74	7.3	2.2	23.0	28.3	48.7	2.29
L37	3.88	.93	16.3	68	6.1	2.5	19.3	18.3	62.0	1.48
L53	3.45	.84	17.8	73	6.1	2.2	18.3	16.5	65.2	1.29
C17	4.87	1.11	16.3	72	7.3	2.3	22.7	26.3	51.0	2.20
F6	4.94	1.18	17.5	73	6.8	2.4	26.0	21.8	52.5	2.30
Mean	4.81	1.16	17.7	73	7.0	2.4	20.8	21.9	57.2	2.06
LSD.05	1.49	0.35	0.9	2.8	0.7	0.3	4.3	4.1	7.4	0.54

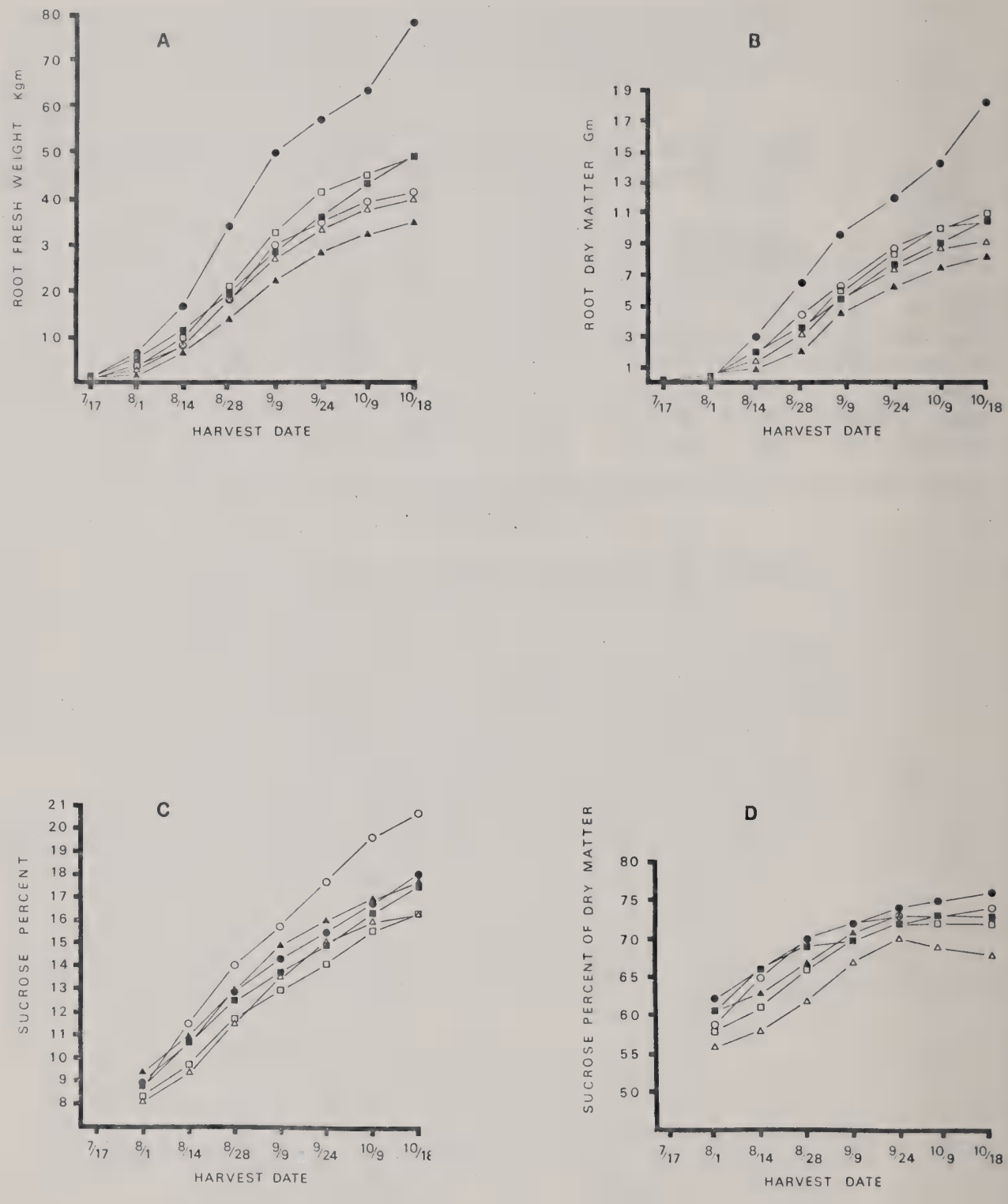

Figure 1. (A) Root Fresh Weight, (B) Root Dry Matter, (C) Sucrose Percent, (D) Sucrose Percent of Dry Matter of six sugarbeet inbred lines. Logan, Utah, 1979. 0 = L19, ● = L10, Δ = L37, ▲ = L53, □ = C17, ■ = F6.

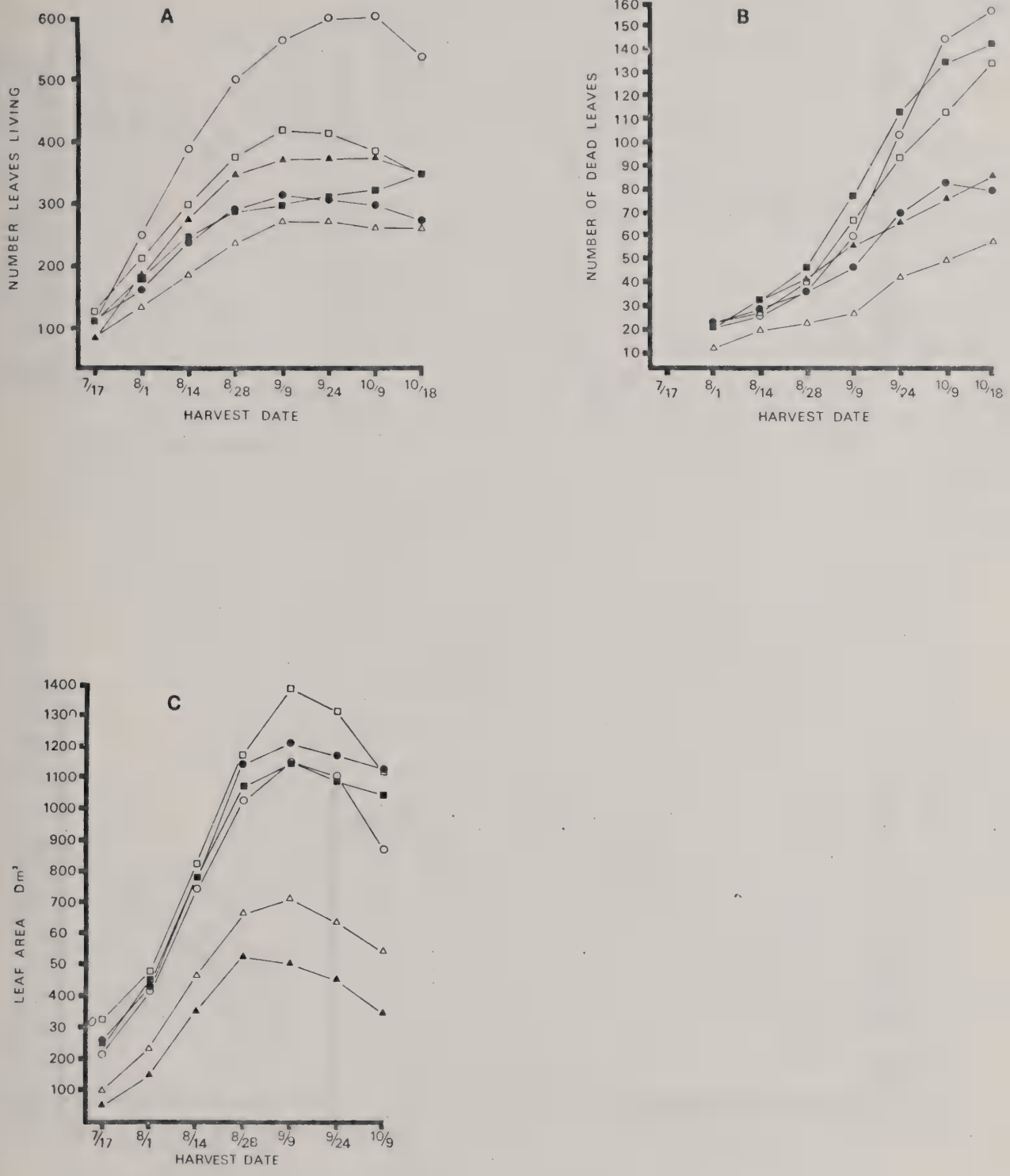

Figure 2. (A) Number Living Leaves, (B) Number Dead Leaves, (C) Leaf Area of Six Sugarbeet Inbred Lines, Logan, Utah, 1979. ○ = L19, ● = L10, Δ = L37, ▲ = L53, □ = C17, ■ = F6.

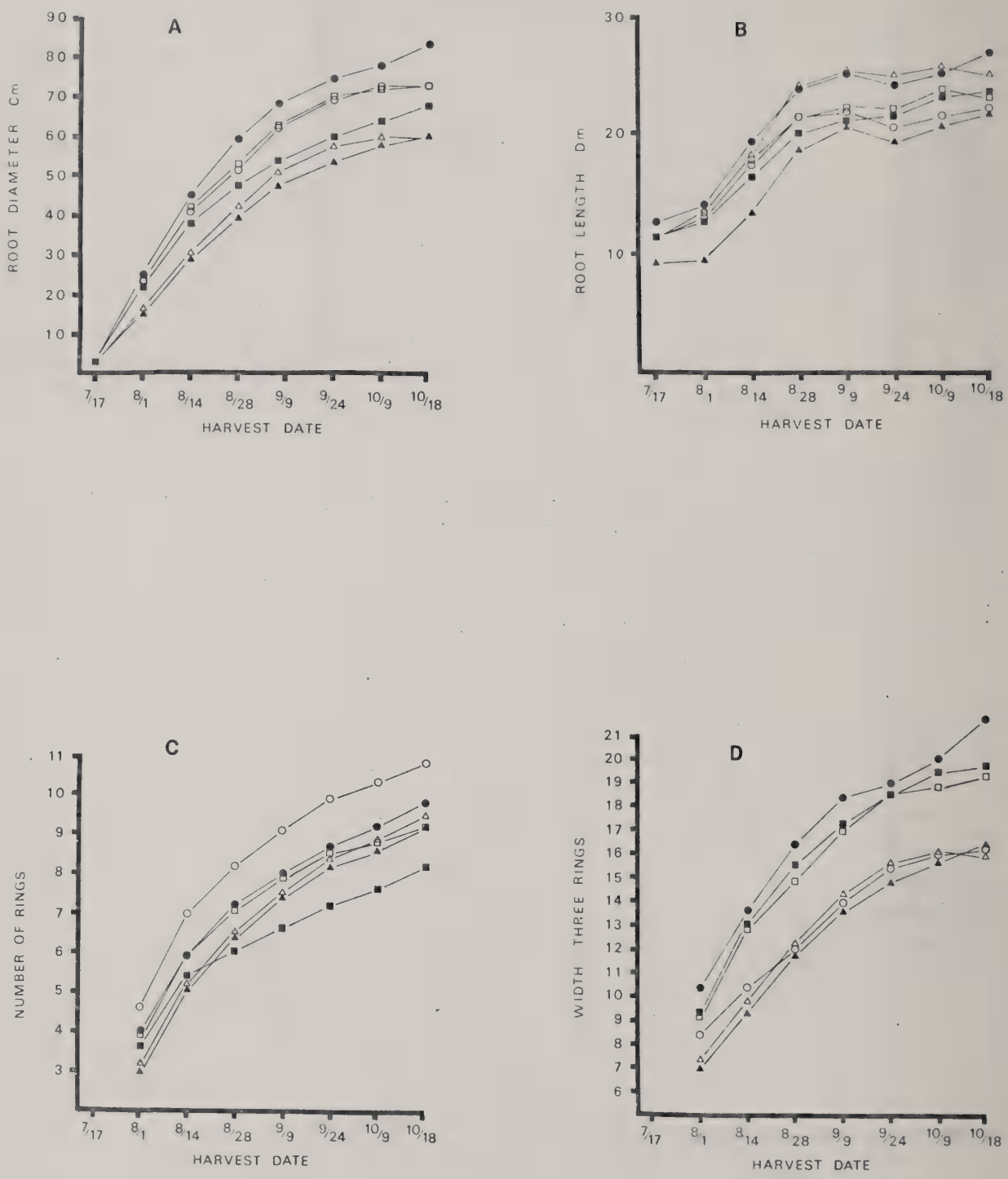

Figure 3. (A) Root Diameter, (B) Root Length, (C) Number of vascular rings in root, (D) Width of First Three (from center core outward) vascular rings of six sugarbeet inbred lines, Logan, Utah, 1979. 0 = L19, ● = L10, Δ = L37, ▲ = L53, □ = C17, ■ = F6.

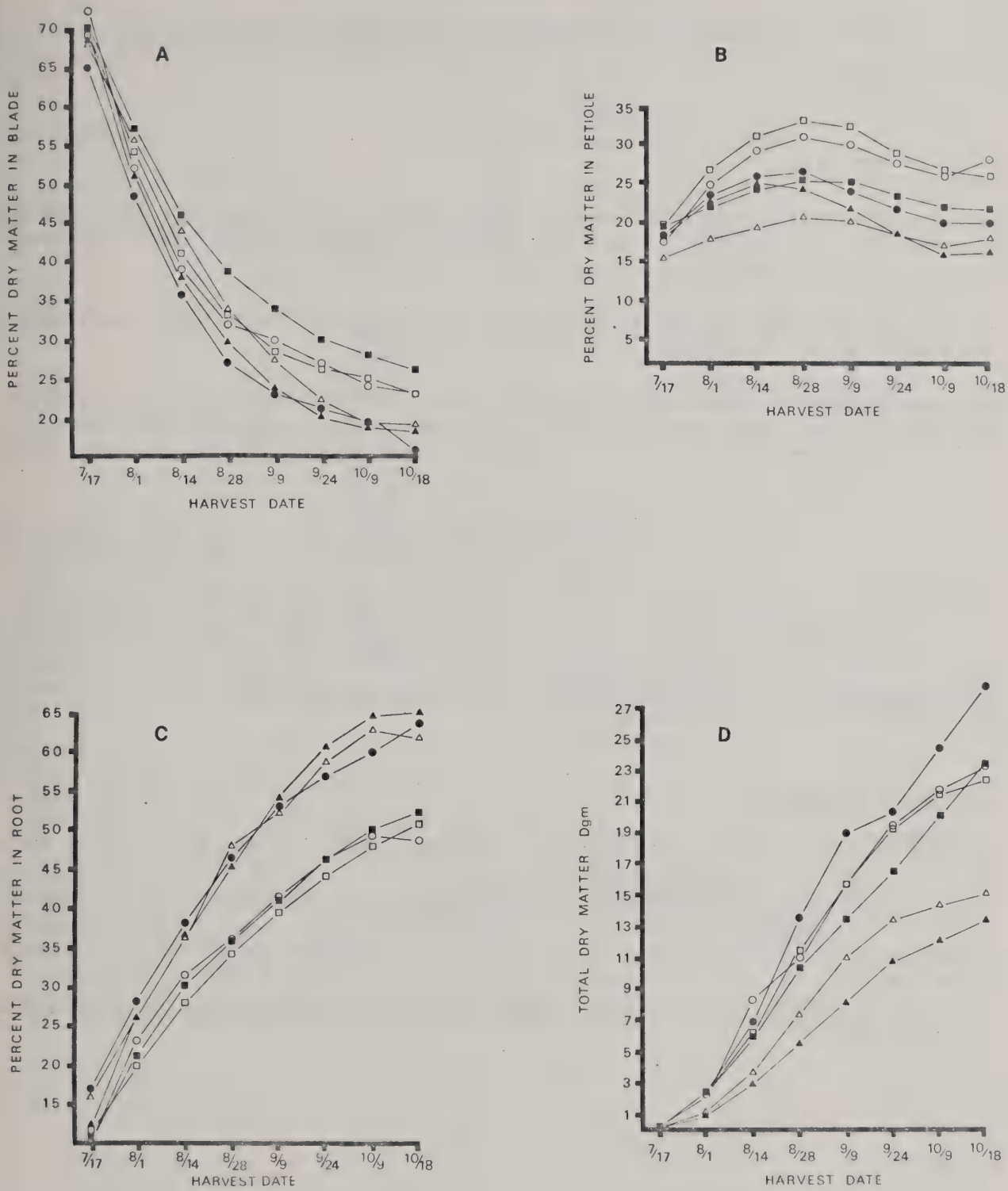

Figure 4. (A) Percent of Total Dry matter in leaf blades, (B) Percent of total dry matter in petioles, (C) percent of total dry matter in roots, (D) Total dry matter of six sugarbeet inbred lines, Logan, Utah, 1979. 0 = L19, ● = L10, Δ = L37, ▲ = L53, □ = C17, ■ = F6.

V. MALE STERILITY STUDIES

A LOOK AT NEW CYTOPLASMIC MALE-STERILE LINES

J. C. Theurer

Japanese CMS Lines:

Japanese scientists have published several papers indicating that they had discovered different sources of sterile cytoplasm in sugarbeets. These diverse sources resulted from gamma irradiation of sugarbeet seed.

In 1977, a very small quantity of seed segregating for these male steriles was obtained from Dr. Kinoshita of Hokaido University.

Seed was planted in greenhouse pots and male-sterile plants segregating from these populations were crossed with O-type and pollen restorer type inbreds. F_1 progenies were evaluated in the greenhouse in 1979. The results are shown in Table 1.

Japanese CMS lines crossed to known O-type testers (NB-1, L53) gave almost exclusively male-sterile plants suggesting that these plasms are probably not any different than the sterile plasm discovered in U.S. by F. V. Owen. Crosses with L19 give either O type or partial restorer fertile plant segregation as would be expected from crosses with different L19 plants. Restorer testers (L60, 572Rf) gave mostly fertile offspring. Results to date tend to disagree with Japanese conclusions that these lines have entirely different sterile plasm from the American source.

Russian CMS Lines:

In seed exchange of U.S. and Russian germplasm, one line was reported as cytoplasmic male sterile. The O-type equivalent was also received at the same time. The results of F_1 crosses with O type and the annual 572 Rf restorer germplasm are shown in Table 2. The cross with L53 cms gave 100% male-sterile offspring suggesting that the sterile plasm is the same as in the U.S. source of male sterility. The cross with the annual restorer which is governed mainly by a single restorer gene showed a segregation of three fertile to one male sterile.

Table 1. Fertility of F_1 crosses between Japanese CMS lines and Logan, O-type and pollen-restorer inbreds 1979.

Cross		No. Plants Fertile	No. Plants Male Sterile
60 (Si-2)	xL19	30	15
"	xL19	26	0
"	xNB-1	0	49
"	xL53	0	27
114 (Si-4)	xL19	39	43
"	xNB-1	0	2
"	xL53	0	25
"	xL60	66	0
130 (Si-3)	xL19	33	17
"	xNB-1	0	32
"	xL53	0	31
"	xL60	72	7
"	x572R_f	35	0
165 (Si-3)	xL19	12	1
"	xNB-1	0	60
"	xL60	17	1

Table 2. Fertility of a Russian CMS and O-type line in crosses with U.S. O-type and pollen-restorer lines.

Cross	No. Plants Fertile	No. Plants Male Sterile
CMS x 752 R_f	51	165
CMS x L53	0	91

VI. INSECT STUDIES

SELECTION FOR RESISTANCE TO THE SUGAR BEET ROOT MAGGOT

J. C. Theurer, C.C. Blickenstaff, D. L. Doney

The cooperative research to evaluate and select for resistance to the sugar-beet root maggot was continued in 1979. Seed increases were made of 1978 selected roots in isolation chambers and in the greenhouse at Logan during the winter of 1979. Field tests were carried out at Kimberly, Idaho, in three sections.

Section I

This group consisted of seed increases from the 1978 high-damage and low-damage selections out of the heterogenous population 35F3, the 35F3 parent and the inbred check L29. This was the first evaluation of high-low selection in the 35F3 population. The four entries were planted in 4-row plots (40 plants/row) with 13 replications. Damage ratings were made as in previous years on a 1 to 5 scale (1 least damage - 5 dead plants). They were also scored on the basis of percent good plants. The results are given in Table 1. Differences among the entries were highly significant for damage ratings and the percent of good plants that did not show maggot symptoms. There was a nonsignificant correlation of $r = 0.618$, $n = 4$ between the two ratings based on entry means. Twenty-four low-damage plants were selected for seed increase and repeated selection in 1980.

Section II

This group consisted of five entries: two low-damage selections, one high-damage selection, the parent population 25A2 and L19 check. The low-damage selections were the fourth selection cycle from 25D47-48. This population has 50% of the genetic background of 25A2, and was included in selection studies after the first selection cycle, when seed increase from the selected 25A2 plants was poor. It was included in this test in place of 25A2 cycle 4 selections because of insufficient seed of the latter. The entries were planted in 4-row (40 plant) plots with 11 to 15 replications in a completely randomized experiment. Ratings were made using the usual 1 to 5 rating scale and also by estimating the percentage of plants that did not show maggot symptoms.

Differences between the entries for damage ratings and also for percentage of good plants were significantly different. (Table 2). Twenty roots were saved from the low-damage 40H7 line and 24 roots were saved from the 4063+a low-damage line, for further selection.

Table 3 shows the progress for maggot resistance for four cycles of selection in population 25A2. The 1979 low-damage figures were estimated from Section III 40H8-4 and 40H8-5, selfed lines from 25A2 C3 selections. Selection for low-damage for the fourth cycle has resulted in 20% less maggot damage than the original heterogenous population from which the selections were initiated in 1975.

Table 1. Sugarbeet root maggot damage ratings and percentage good plants from the 35F3 population, Kimberly, Idaho, 1979.

Seed No.	Description	Damage Rating Mean	% Good Plants	% of Parent
40H4	35F3 Low Damage	2.8 a[1/]	60.9 a	82
929	L29 Check	3.3 b	37.9 c	
35F3	Parent	3.4 b	51.8 ab	
40H6	35F3 High Damage	3.9 c	44.7 bc	115

[1/] Duncan's multiple range 5% - means with same letter are not significantly different.

Table 2. Sugarbeet root maggot ratings and percentage good plants from the 25A2 population. Kimberly, Idaho, 1979.

Seed No.	Description	Damage Rating Mean	% Good Plants	% of Parent
40H7	25A2 Low Damage	2.8 a	50.6 a	85
40G3 + a	25A2 Low Damage	3.3 b	50.5 a	97
25A2	Parent	2.4 b	40.1 b	
719	L19 Check	3.9 c	47.7 ab	
40H2	25A2 High Damage	3.9 c	31.5 c	115

Table 3. Maggot damage rating in % of percent population 25A2 for four cycles of selection.

Selection	1976	1977	1978	1979*
High Damage	116	103	121	114
Low Damage	96	86	89	80
Differences High vs. Low	20	17	32	34

* See Narrative

Section III

The third section of this cooperative research included selfed and sibbed individual beet selection progenies made in 1977 and 1978. Twenty-one entries from individual beet selections plus L29 and L89 checks were planted in a completely randomized experiment. Entries were single-row plots with 2-34 replications per entry, dependent upon the quantity of seed available for planting. The selections were all low-damage maggot selections. The data are summarized in Table 4. Differences between entries were highly significant, and ranged from scores of 2.7 to 3.6. Recurrent selection will be used to attempt further low-damage selection in the better lines.

Table 4. Sugarbeet root maggot damage ratings of individual plant selections for low damage in 1977 and 1978, Kimberly, Idaho, 1979.

Selection No. Logan Designation	Mean	% Good Parents	Orig. Parents	Selection Cycle
40H8-4	2.7 a	91.0 ab	37	C4
40G14+a	2.7 a	100 a	18	C3
40H8-5	2.8 ab	90.4 ab	49	C4
40G4	2.9 ab	72.3 cdef	28	C3
40H10-3	3.0 abc	60 efghi	55	C2
40H9-3	3.1 abc	68.3 cdefgh	90	C3
40H9-5	3.1 abc	80 bcd	100	C3
40H10-1	3.1 abc	63.2 defghi	98	C2
40H10-4	3.1 abc	80.3 bcd	86	C2
40G13+a	3.1 abc	82.1 bc	65	C3
40H11-2	3.2 abc	61.7 defghi	54	C2
40G2	3.2 abc	63.5 defghi	19	C2
40G12+a	3.2 abc	75.2 bcde	93	C2
40H10-2	3.4 abc	49.7 hi	105	C2
40H11-3	3.4 abc	61.5 defghi	107	C2
40H9-4	3.5 abc	52.1 ghi	69	C3
40H11-4	3.6 bc	52.2 ghi	110	C2

VII. SUGARBEET DISEASE STUDIES

REACTION OF SUGARBEET LINES TO POWDERY MILDEW

D. L. Mumford and J. C. Theurer

Since its initial widespread occurrence in 1974, powdery mildew has consistently ranked as one of the most serious diseases of sugarbeet in the western United States. Although chemical control measures have been very effective in reducing losses, the development of resistant cultivars seems an economically and environmentally desirable long-range objective. With this objective in mind we have been evaluating a wide variety of sugarbeet lines for reaction to powdery mildew. Initial evaluations were carried out by inoculating medium-aged plants in the greenhouse. For the past four years sugarbeet lines have been evaluated in the field with natural infection. Also during the past four years attempts have been made to determine whether seedlings could be evaluated as a means of identifying resistance.

Methods of inoculating and obtaining good disease development on young seedlings have been developed. Contrary to the widely held assumption that only mature plants become infected, we can obtain good disease development on cotyledons and first true leaves of seedlings. Considerable effort has been directed toward correlating the reaction to powdery mildew of cotyledons artificially inoculated and the reaction of mature plants in the field. To date the correlation has not been high enough to utilize a seedling method of identifying resistance.

Field evaluations have shown that there is a wide range of reaction among sugarbeets to powdery mildew (Table 1). The sugarbeet lines have been listed in Table 1 from most resistant to most susceptible. The ratings for different years for those lines that were evaluated on two or more years are very consistent.

A general observation can be made about the reaction of lines listed in Table 1 and some additional lines that were evaluated for only one year. The majority of lines that have been rated resistant to powdery mildew (a rating of two or less) are susceptible to beet curly top virus, while the majority of lines rated susceptible to powdery mildew are resistant to beet curly top virus. Logan line L56 is of interest because it has considerable resistance to both diseases.

Research in progress will continue to search for a more rapid means of evaluating younger plants and attempt to obtain information on how powdery mildew resistance is inherited.

Table 1. Field evaluations of sugarbeet lines for resistance to powdery mildew

Description	Disease Severity Rating[a/]			
	1976	1977	1978	1979
L37	1.0	1.0	1.1	
FC504		1.0	1.3	1.0
EL40		1.3	1.3	1.0
8513	1.0	2.0	1.3	1.0
S72-314				1.4
S72-316				1.4
L53	1.5	2.0	1.7	1.0
53100-04				1.7
S72-315	2.0	2.4	2.4	
L56				2.2
S72-302			2.6	
1345			3.1	2.2
L8		3.5	3.3	3.2
L19	3.5	3.3	3.4	3.3
HH28				3.4
NB-1		3.5	3.7	
U+I8		3.8		3.5
D-2		4.0	3.6	3.6
HH7				3.7
HH22			4.1	3.6
AH12			4.2	3.7
L10	4.3	4.5	3.7	3.5
8193	4.5		4.8	
A5	4.5	5.0	4.8	3.5
L54		4.8	5.0	5.0

[a/] Rating based on scale of 1-5 with 1 = very slight mycelium development and no evidence of sporulation and 5 = heavy mycelium development and abundant sporulation.

Ratings are average of four replications in 1976, 1977, 1979, and eight replications in 1978.

VIII. PHYSIOLOGY-BIOCHEMISTRY STUDIES

CONTROL OF PHOTOSYNTHATE PARTITIONING WITHIN THE SUGARBEET ROOT

Roger Wyse

Introduction

Understanding how a plant controls the allocation of available fixed carbon (sucrose in the leaf) to economically important sink regions (root, tuber, leaves, etc.) will facilitate eventual genetic and chemical control. Such control will allow more efficient genetic selection of superior genotypes and identification of growth-regulating chemicals.

This past year we have shown that the capacity of the sugarbeet root to assimilate translocated sucrose is regulated by potassium ions and the hormones abscisic acid (ABA) and indoleacetic acid (IAA).

Results and Discussion

Characteristics of sucrose uptake: We have used sucrose uptake from dilute ^{14}C sucrose solutions and subsequent compartmental analysis (Maclon and Higinbotham, 1970) to study sucrose uptake into root sink tissue. The results have identified three distinct compartments within the tissue which are assumed to be the cell wall-free space, cytoplasm and vacuole (Maclon and Higinbotham, 1970; Kholodova, 1967). The results show no significant differences between the concentrations of sucrose in the free space and cytoplasm, but an obvious concentraton increase across the tonoplast (Table 1).

Table 1. Compartmentation of Sucrose in Sugarbeet Root Cells. Volumes of vacuole and cytoplasm were estimated by measurements made on electron micrographs. Free space volume was estimated by the method of Parr and Edelman (1976). Sucrose in each compartment was estimated by efflux pattern and compartmental analysis (Maclon and Higinbotham, 1970).

Compartment	Compartment Volume	Sucrose Content	Sucrose Concentration
	%	mg/gm fw	mM
Free Space	10	2.0	60
Cytoplasm	7	1.6	76
Vacuole	70	120	514

Temperature effects (Table 2) and the metabolic uncoupler CCCP (Table 3) were used in conjunction with compartmental analysis to determine the degree of active (energy requiring) and passive uptake occurring at the plasmalemma and tonoplast (10^{-5} M CCCP inhibited respiration 98%). Results show only passive movement of sucrose across the plasmalemma but both active and passive movement of glucose at the same site. Transport of sucrose at the tonoplast showed both an active (85%) and passive exchange component (15%).

Table 2. Effect of Temperature on the Uptake and Compartmentalization of Sucrose. Sucrose uptake by sugarbeet root tissue disks was determined in 40 mM sucrose in 1 mM MOPS (pH 7.0) ± CCCP at 5, 15 and 30 degrees C. Uptake into each compartment was determined by compartmental analysis.

Temperature Range	Temperature Response, Q_{10}		
	Free Space	Cytoplasm	Vacuole
5-15°C	1.0	1.0	3.5
15-30°C	1.0	1.0	2.4

Active sucrose uptake in subsequent studies using tissue disks was defined as uptake in the absence of CCCP minus uptake in the presence of CCCP and was assumed to occur only at the tonoplast.

Table 3. Effect of CCCP on Sucrose and Glucose Uptake and Compartmentalization. Disks (1 x 6 mm) were incubated in 1 mM MOPS (pH 7.0), 40 mM ^{14}C-sugar ± 10^{-5} CCCP for 6 hrs. Radioactivity in each compartment was determined by compartmental analysis.

Treatment	Free Space	Cytoplasm	Vacuole
		$\mu mol \cdot h^{-1} \cdot g^{-1}$	
Sucrose			
Control	.44	.56	.30
+ CCCP	.44	.56	.05
% Active	--	--	83
Glucose			
Control	.47	.49	.10
+ CCCP	.48	.17	.06
% Active	--	65	40

The rapid passive exchange of sucrose at the plasmalemma has several implications in determining the pathway of sucrose movement at the site of phloem unloading (Wyse and Saftner, 1979). The question of apoplatic vs. symplastic movement is of little consequence because the rapid exchange ($t_{\frac{1}{2}}$ of approximately 20 min) facilitates an equilibrium between the two compartments. Thus any gradient of sucrose away from the site of phloem unloading would exist both in the free space and in the cytoplasm. These results also suggest that the concentration of sucrose in both the free space and cytoplasm may be "sensed" by the phloem and would thus contribute to the gradient between source and sink. (This gradient controls sucrose flux to sink areas.)

Sucrose uptake into sugarbeet root tissue was found to be linear over the range of 0.5 to 500 mM (Wyse, 1979) while both glucose and fructose showed

saturation kinetics. However, these early experiments did not differentiate between active and passive uptake and did not account for net efflux occurring at low external concentrations. We have since determined both active and passive sucrose uptake at various external concentrations (Figure 1). When tissue slices are placed in 1 mM MOPS (pH 7.5, 15 disks/ml-1 x 6 mm disks), sucrose is released from the tissue until the external sucrose concentration approaches 25 to 30 mM. (The final concentration is related to sucrose content of the tissue).

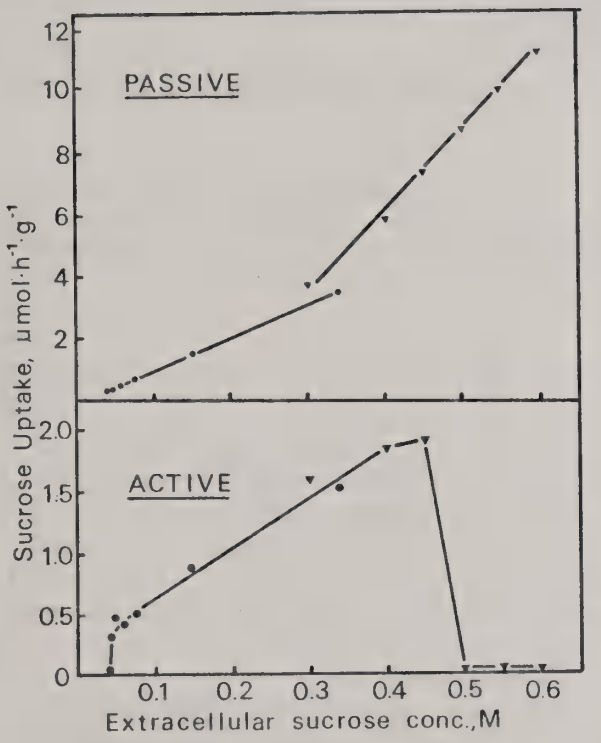

Figure 1. Active and passive sucrose uptake at various extracellular sucrose concentrations. Tissue disks were placed in K·MOPS buffer (1 mM, pH 7.5) with a ratio of 15 disks/ml and allowed to release sucrose until equilibrium was reached. ^{14}C-sucrose was then added to the equilibrium solution to increase the concentration by the desired amount. Active and passive uptake were as described previously. The two symbols represented data from two separate experiments.

Additions of sucrose above this equilibrium level result in a rapid increase in net uptake of sucrose. However, at 10-15 mM above the equilibrium concentration, active sucrose uptake becomes linear to concentrations causing tissue plasmolysis. These data suggest an uptake mechanism which is very responsive to small changes in free space sucrose concentrations, but which does not saturate even at high (unphysiological) external sucrose concentrations. Thus the sucrose carrier mechanism is totally responsive to sucrose concentrations normally found in the apoplast (30-150 mM). Passive sucrose uptake was linear over the entire range tested. Facilitated diffusion of sucrose at the plasmalemma could not be substantiated (no evidence for passive saturation kinetics).

Our model (Figure 2) for sucrose uptake and storage in the vacuole of sink tissues (Saftner and Wyse, 1979) would suggest that the sucrose uptake mechanism

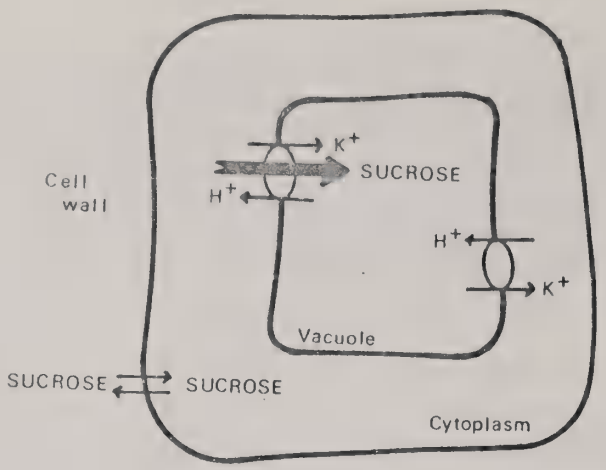

Figure 2. Proposed model for sucrose uptake in the sugarbeet root sink parenchyma cells, Saftner and Wyse (1980). Passive sucrose exchange occurs at the plasmalemma. Sucrose transport across the tonoplast is coupled to a H^+/K^+ exchange reaction. The H^+ and K^+ gradients are generated by a vectorial ATPase on the tonoplast.

is sensitive to small changes in apoplastic sucrose concentrations and is infinitely responsive to photosynthate supply (sucrose uptake does not saturate at high external sucrose concentration). However, uptake could be limited if the potassium/proton gradients were degraded, i.e., after prolonged transport or during periods of high photosynthate supply. Under these conditions, ATPase activity may not be adequate to maintain the proton/potassium gradients at optimum levels. To test this possibility, sucrose uptake capacity of root sink tissue was determined in sugarbeet plants treated to alter their photosynthate supplies. Field-grown plants were either shaded (85% reduction in photon flux density) for various lengths of time prior to sampling in order to reduce photosynthate supply or exposed to enhanced CO_2 levels (1000 $\mu l \cdot l^{-1}$) to increase photosynthate supply. Results show that indeed the sink strength is inversely correlated to the supply of photosynthate (Table 4).

Table 4. Sucrose uptake by sugarbeet root tissue slices taken from plants exposed to various lengths of light or 1000 ppm CO_2 prior to 1600 hr. sampling.

	Expt. 1		Expt. 2	
Treatment	Active	Passive	Active	Passive
		$\mu mol \cdot h^{-1} \cdot g^{-1}$		
Normal Day Length (10 hrs.)	.23	.35	.36	.34
Normal plus 1000 ppm CO_2	.18	.37	.27	.33
6 hour light			.44	.31
3 hour light			.49	.35
1 hour light			.55	.39
0 hour light	.38	.41	.67	.37
LSD (.05)	.04	.04	.06	.03

Therefore, during periods of maximum photosynthesis or prolonged photoperiods, the root's ability to accept assimilates declines. These results may explain the need for alternate sinks (pod, stem, and petiole) to increase the total

sink capacity (Thorne, 1979; Upmeyer and Koller, 1973) as well as the decline in photosynthesis and increase in starch accumulation in source leaves during extended photoperiods (Chatterton and Silvius, 1979) or in late afternoon (Upmeyer and Koller, 1973).

Since IAA and ABA have been shown to affect ion transport across membranes (Van Steveninck, 1976), their effect on sucrose uptake was studied (Saftner and Wyse, 1979). Concentrations of IAA above 10^{-9} M inhibited sucrose uptake in high potassium (Figure 3). In low K^+, high concentrations were required to inhibit uptake. ABA stimulated sucrose uptake in low potassium but inhibited sucrose uptake at high external potassium concentrations. We find a consistent 50-60% stimulation of sucrose uptake by ABA in mature sink tissue. However, the response is less consistent in rapidly growing tissue.

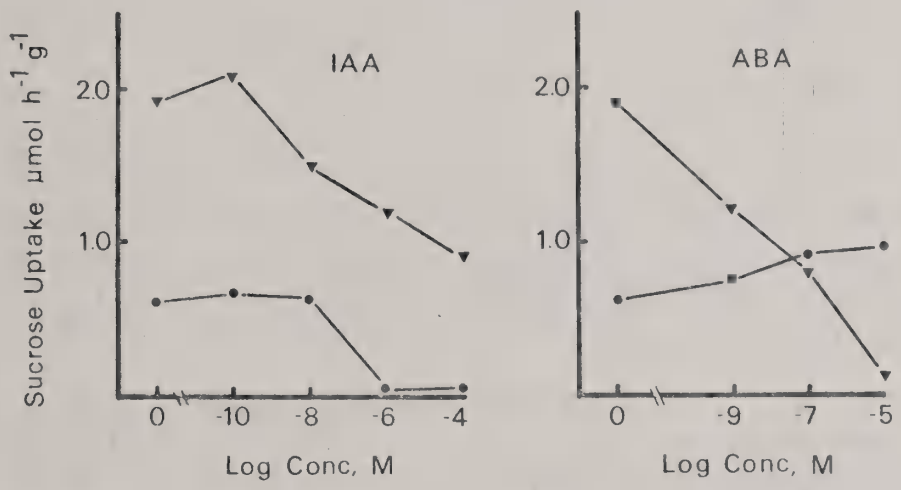

Figure 3. Effect of IAA and ABA on active sucrose uptake in either 5 or 100 mM K^+. (▼) - 100 mM K^+, (●) - 5 mM K^+. The uptake procedure was as described in Table 7.

This stimulation of sucrose uptake by ABA in sink tissues is very exciting in light of some recent work reported in the literature. As discussed previously ABA has been shown to accumulate in sink tissue during periods of rapid growth. It is not known whether the accumulation is a result of ABA synthesis in the sink or translocation from the leaf (Dewdney and McWha, 1978a). Nevertheless, ABA stimulated transport to developing wheat kernels (Dewdney and McWha, 1979b). More recently, ABA has also been shown to stimulate sugar accumulation in roots by increasing translocation from shoot to root of beans (Karmoker and Van Steveninck, 1979b). Karmoker and Van Steveninck (1978) had previously shown that ABA may affect potassium uptake in the bean roots, thus suggesting that there was a relationship between potassium uptake and sugar translocation. Potassium also affects sucrose levels in the leaf apoplast, presumably by facilitating sucrose export from mesophyll cells (Doman and Geiger, 1979). However, potassium inhibits phloem loading (Servaites and Schrader, 1978; Doman and Geiger, 1979). These observations suggest a key role for ABA and potassium in regulating sucrose levels both in source and sink.

On a whole plant scale, this regulatory effect of potassium on sucrose uptake by sink tissue may explain earlier results that indicated a potassium-enhanced

transport of assimilates to sinks (Haeder, 1973; Mengel and Viro, 1974). These potassium effects may be on phloem loading (Mengel and Haeder, 1977) enhanced by higher apoplastic sucrose concentrations (Doman and Geiger, 1979), and/or stimulated sucrose uptake by sink regions.

From our recent results, it is concluded that the sink is a key component in the integrated and dynamic system controlling photosynthate supply and partitioning. Sucrose uptake, metabolism and storage are important factors regulating the mobilizing ability of sink regions. In sugarbeet, this mobilizing ability or sink strength may be related to the ability of the sink to maintain low apoplastic sucrose levels--a condition which promotes sucrose translocation from source to sink. Since K^+, IAA and ABA control the sucrose uptake capacity of sink tissue, their role in photosynthate partitioning and source-sink communication merits further study.

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SUGARBEET RESEARCH

1979 Report

Section C

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This research was supported in part by funds provided through the Beet Sugar Development Foundation (Projects 20, 25, 53, and 54)

CONTENTS

ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION AND GERMPLASM RELEASES AND REGISTRATIONS, 1979

HECKER, R. J. and E. G. RUPPEL. Release of sugarbeet germplasm resistant to Rhizoctonia root rot. Joint release of USDA-SEA, Beet Sugar Development Foundation, and Colorado State University Experiment Station.

FC 708 is the monogerm type O maintainer of FC 708 CMS. FC 708 is self-fertile, has low vigor, and is partially inbred.

FC 708 CMS is the cytoplasmic male sterile BC_2 equivalent of FC 708. The nonrecurrent parent was a vigorous CMS line which was moderately resistant to Cercospora leaf spot and the curly top virus.

FC 708 and FC 708 CMS are moderately bolting resistant, have low vigor and high crowns, but are phenotypically heterogeneous. This is the first release of monogerm CMS and type O germplasm highly resistant to root rot induced by *Rhizoctonia solani*. These germplasms have no potential for direct use by growers; they are intended for use by breeders as monogerm type O and CMS source parents for Rhizoctonia resistance.

MARTIN, S. S. Sugarbeet. Chapter 14 in Teare, I. D. (Ed.), Crop-Water Relations. Wiley-Interscience, N. Y. Probable date of publication, 1981.

This chapter reviews the water requirements of sugarbeets at various stages of growth, and describes the effects of water deficit on growth and productivity.

RUPPEL, E. G. Controlling preharvest fungal diseases of sugar beet. IX Intern. Cong. Plant Prot. and 71st Ann. Meeting Amer. Phytopathol. Soc. Abstracts of Papers, No. 754. 1979. [Symposium papers to be published at some future date.]

Pre- and postemergence damping off, cercospora leaf spot, and powdery mildew are the most widespread economically important fungus diseases affecting sugar beet which require active integrated programs of control. Root rots, rust, wilts, and downy mildew are of local importance in certain countries. Control of the more serious diseases has been achieved by the incorporation of genetic resistance, coupled with protection and chemotherapy with appropriate fungicides. Black leg incited by *Aphanomyces* generally is controlled by use of resistant cultivars, and by seed and soil treatment with fungicides. The use of pathogen-free seed and fungicide seed treatment somewhat controls phoma black root. Control of powdery mildew is accomplished with inexpensive sulfur compounds, although resistance to *Erysiphe* has been reported. With cercospora leaf spot, the most widespread disease of sugarbeet, a negative correlation between resistance and sugar yield has forced breeders in the past to settle for intermediate degrees of resistance. Thus, in areas where the disease often is epiphytotic, adequate control is attained only by use of supplemental fungicides. In Europe, where reliance

on fungicides has been the major control measure for leaf spot, development of benomyl-tolerant pathogen strains has regenerated interest in breeding for genetic resistance.

RUPPEL, E. G., A. D. JENKINS, and L. M. BURTCH. Persistence of benomyl-tolerant strains of *Cercospora beticola*. Phytopathology 70:25-26. 1980.

In 1976 and 1977, 98 to 100% of *Cercospora beticola* isolates obtained from diseased sugarbeets near Willcox, AZ, growing in benomyl, triphenyltin, treated and nonsprayed fields grew in PDA containing 5 µg a.i. benomyl/ml. Benomyl-sensitive isolates from Colorado were inhibited completely by 0.1 µg benomyl/ml. In 1978, 100% of the isolates from a triphenyltin-sprayed field also were tolerant to 100 µg benomyl/ml. The level of tolerance declined considerably between 1976 and 1977. In 1976, all isolates from benomyl-sprayed and nonsprayed fields grew in PDA containing 1,000 µg benomyl/ml, whereas only 71% of the isolates from the triphenyltin-sprayed field grew at this concentration. In 1977, only 1, 1, and 0% of the isolates from benomyl-sprayed, nonsprayed, and triphenyltin-sprayed fields, respectively, grew in PDA with 1,000 µg benomyl/ml. All of the isolates from 1978 grew at 10 µg/ml, but none grew in PDA with 100 or 1,000 µg/ml. Most Arizona isolates of *C. beticola*, whether from sprayed or nonsprayed fields, were 100-1,000 times more tolerant to benomyl in vitro than sensitive control isolates from Colorado over the 3-yr study. Thus, benomyl-tolerant strains of *C. beticola* showed a high degree of persistence in the absence of benomyl, even in fields where triphenyltin was used for leaf spot control.

RUPPEL, E. G., C. L. SCHNEIDER, R. J. HECKER, and G. J. HOGABOAM. Creating epiphytotics of rhizoctonia root rot and evaluating for resistance to *Rhizoctonia solani* in sugarbeet field plots. Plant Dis. Reptr. 63:518-522. 1979.

Uniform epiphytotics of sugarbeet root rot induced by *Rhizoctonia solani* were initiated at Fort Collins, Colorado and East Lansing, Michigan, with mechanical applications of dry ground barley-grain inoculum in the center of the row with a modified granule applicator. Equipment, inoculum preparation, field rates, and disease evaluations, while basically similar, differ in details at the two locations. These methods were effective and reliable for use in evaluations of sugarbeet cultivars for resistance to the fungus.

SMITH, G. A. and E. G. RUPPEL. Release of sugarbeet germplasm. Official joint release of the USDA-SEA, Beet Sugar Development Foundation, and Colorado State University Experiment Station, June 21, 1979.

FC 607 and FC 607 CMS combine high resistance to *Cercospora beticola* the incitant of leaf spot, with moderate resistance to the beet curly top virus. The lines are monogerm, diploid (2X = 18), and flower after short photothermal induction. FC 607 is the pollen-fertile maintainer line of FC 504 X 502/2 X FC 605 in which FC 605 represents one-half the genetic contribution. It is a type O line with high *Cercospora* and moderate curly top virus resistance. The line is a good seed producer, moderably vigorous,

hence, the CMS has potential for use as a parent in single cross hybrids. In limited testing, the line has shown good combining ability for sucrose content. FC 607 CMS is the cytoplasmic male sterile equivalent of FC 607. These lines are suggested for use as parental components of hybrids where genes for combined resistance to Cercospora and curly top virus are needed.

SMITH, G. A. and E. G. RUPPEL. Registration of FC 606 and FC 606 CMS sugarbeet germplasm. (Reg. Nos. GP 52 and GP 53) Crop Sci. 19:300.

Sugarbeet (*Beta vulgaris* L.) breeding lines FC 606 and its cytoplasmic male-sterile equivalent, FC 606 CMS, were developed by AR, SEA, USDA, in cooperation with the Beet Sugar Development Foundation and the Colorado State University Experiment Station. These lines have resistance to cercospora leaf spot (incited by *Cercospora beticola* Sacc.) and the curly top virus. The lines are diploid (2X = 18) and flower after short photothermal induction. FC 606 (GP No. 52) is the monogerm, pollen-fertile maintainer line (type O) of FC 606 CMS. This line was developed from the three-way cross, (652016s1 X 662119s1) X FC 605 (FC 605 Registration No. GP 50). The line is moderately vigorous; hence, the CMS has potential for use as a parent of single-cross hybrids. FC 606 has high resistance to leaf spot (slightly less than US 201) and moderately high resistance to curly top (superior to that in US 41).

FC 606 CMS (GP No. 53) is the cytoplasmic male-sterile monogerm equivalent of FC 606 which was the result of the cross of (652016s1 CMS X 662119s1 T.O.) X FC 605 T.O. FC 606 CMS, as the female parent in experiment hybrids, has shown good combining ability for sucrose content as well as disease resistance.

These lines are intended for use as parents of hybrids to be developed for situations in which genes for combined resistance to leaf spot and curly top are needed.

Breeder seed is maintained by AR, SEA, USDA, and is provided upon written request to sugarbeet breeders in quantities sufficient for reproduction. Requests for seed should be made to Dr. G. A. Smith, AR-SEA-USDA, Crops Research Laboratory, Colorado State University, Fort Collins, CO 80523.

STEINKAMP, M. P., S. S. MARTIN, L. L. HOEFFERT, and E. G. RUPPEL. Ultrastructure of lesions produced in leaves of *Beta vulgaris* by cercosporin, a toxin from *Cercospora beticola*. Approved by SEA for submittal to Physiol. Plant Pathol.

The fungus *Cercospora beticola* Sacc. forms in culture at least two metabolites that can produce necrotic lesions when applied exogenously to leaves of sugarbeet, *Beta vulgaris* L. Lesions produced 5 days after application of cercosporin (CN), one of the toxic metabolites, were examined by electron microscopy and compared to lesions incited by the fungus. Both similarities and differences were found in this comparison. Similarities included the presence of large amounts of granular, electron-dense material, especially in the margin of the lesions; presence of cells having electron-dense cytoplasmic ground substance and cell wall appositions; and loss of cell membranes, especially the chloroplast-bounding membrane and tonoplast. Both lesion types contained necrotic cells that had collapsed during the

degenerative sequence. Necrotic cytoplasm within these cells contained starch grains, remnants of the chloroplast lamellar membranes, and sometimes areas that once had held crystalline material. In contrast to fungus-induced lesions, however, CN-induced lesions lacked electron-dense bodies in vacuoles and necrotic remnants, lacked a well-defined boundary zone with generalized wall thickenings, and usually had no increases in the size or number of plastoglobuli.

Published Papers Abstracted in Sugarbeet Research, 1978 Report

HECKER, R. J. and E. G. RUPPEL. Registration of FC 702/4, FC 702/4 (4X), FC 705, FC 706, and FC 707 sugarbeet germplasm. (Reg. Nos. GP 55 - GP 59) Crop Sci. 19:935. 1979.

HECKER, R. J. and G. A. SMITH. Registration of FC 704 sugarbeet germplasm. (Reg. No. GP 54) Crop Sci. 19:934. 1979.

SMITH, G. A. and J. O. GASKILL. Registration of six sugarbeet germplasm lines (Reg. No. GP 42 - GP 47). Crop Sci. 19:131. 1979.

SMITH, G. A. and J. O. GASKILL. Registration of FC 902 sugarbeet germplasm (Reg. No. GP 41). Crop Sci. 19:131. 1979.

SMITH, G. A., R. J. HECKER and S. S. MARTIN. Effects of ploidy level on the components of sucrose yield and quality in sugarbeet. Crop Sci. 19:319-323. 1979.

SMITH, G. A. and E. G. RUPPEL. Registration of four sugarbeet germplasm lines (Reg. No. GP 48- GP 51). Crop Sci. 19:131-132. 1979.

STEINKAMP, M. P., S. S. MARTIN, L. L. HOEFERT, and E. G. RUPPEL. Ultrastructure of lesions produced by *Cercospora beticola* in leaves of *Beta vulgaris*. Physiol. Plant Pathol. 15:13-26. 1979.

RHIZOCTONIA ROOT ROT RESEARCH AND RESISTANCE BREEDING
(BSDF Project 20)

1979 Rhizoctonia Field Research.--R. J. Hecker and E. G. Ruppel.

During 1979, our field research on *Rhizoctonia solani* in sugarbeet was conducted on our BSDF-leased farm where we also conduct the cercospora leaf spot field research. 1979 was the second crop year of the current 3-year lease on the farm.

The rhizoctonia root rot research is carried out in an area of the farm set aside specifically for that purpose; a 4-year rotation (beets, barley, barley, fallow) is utilized. The 1979 nursery area was the same as that used for the rhizoctonia nursery in 1975. There was no noticeable infection by *Rhizoctonia* in the 1979 nursery prior to inoculation.

Three cultural experiments on *Rhizoctonia* involving nitrogen sources, pesticides, and cultivation were planted on the 1978 nursery area and are described in separate sections of this report.

The principal rhizoctonia test area in 1979 was inoculated July 16 with a tractor-mounted, 4-row, granule applicator. The dry, ground barley-grain inoculum of *Rhizoctonia solani* (R-9) was broadcast in a band over each row at the rate of 1.3 grams per meter of row in a split application (opposite directions of travel for each application). One-row plots, 6.1 m long and 56 cm apart were planted May 14. Thinning was done June 7-15. The roots were lifted and individually rated for severity of rot September 17-20. Disease index (DI) ratings were based on a scale of 0 to 7 (0 = no evidence of infection, 7 = plant dead and extensively decomposed). The percentage of healthy roots are those with DI ratings of 0 and 1. The percentage of harvestable roots are those with DI ratings of 1 through 3; it is assumed that all of these plants would be included in the marketed roots. The epiphytotic in our 1979 nursery was about ideal, with highly susceptible populations being almost entirely killed.

The succeeding reports in this section describe our rhizoctonia root rot research in 1979, supported by BSDF Project 20.

Evaluation of Contributed Lines.--E. G. Ruppel and R. J. Hecker.

Separate randomized complete block designs with five replications were used to evaluate a total of 55 contributed lines from American Crystal, Great Western, and Holly Sugar Companies, and from Betaseed, Inc. for post-inoculation resistance to *Rhizoctonia solani*. In each test, *Rhizoctonia* resistant line FC 703 and highly suceptible FC 901 were included as controls. Results of each company's test were statistically analyzed and sent to company breeders; thus, they will not be reproduced here. The mean disease index (DI) across tests for FC 703 on a scale of 0 to 7 was 2.5, whereas for FC 901, the mean DI was 6.1. The range in DI means for all company lines was 3.1 to 6.5. Mean percentage healthy roots (0 + 1 DI's) was 40.1% for FC 703, and 1.0% for FC 901. The range in percentage healthy means for company lines was 0 to 33.9%. Mean percentage harvestable roots (DI's 0, 1, 2, and 3) was 70.3% for FC 703, and 5.5% for FC 901. The range for company lines was 3 to 58% (mean = 26%).

Breeding Sugarbeet for Increased Resistance to Rhizoctonia Root Rot.--
R. J. Hecker and E. G. Ruppel.

The need for rhizoctonia root rot resistance in commercial varieties continues in many of the major sugarbeet production regions of the United States, even though there is some year to year change in the amount of crop loss caused by this root rot. The breeding program for resistance continues with two basic thrusts: first, to increase as much and as rapidly as possible the resistance to root rotting strains of *Rhizoctonia solani*; and second, to incorporate or include with this resistance a genetic background making released breeding lines potentially useful in the development of hybrid varieties by commercial breeders. Hence, in this second thrust we are developing and releasing breeding lines, both multigerm and monogerm, which we hope will find direct use as parents in successful hybrid varieties. Among our multigerm developments and releases we have successfully maintained relatively high levels of genetic variability for all characteristics except *Rhizoctonia* resistance, and in most of these lines it appears that we have developed and maintained relatively high levels of combining ability, considering that the genetic selection pressure was primarily for resistance. Some of the multigerm lines released and in process of development are listed in Table 1. The very best of these is FC 705, a recent release from the program.

The monogerm materials in our breeding program have been derived from hybridizations of various monogerm, leaf spot-curly top resistant sources with our most resistant multigerm lines. The recovery of resistance by selection in the F_2 or in backcross generations has been difficult with one exception; that exception is a backcross to the susceptible parent which under selection yielded a number of lines of excellent resistance. Some of these are listed in Table 2, the best of which are entries 261 and 262. Even though random assortment for resistance was favorable in this case, desirable agronomic characteristics were lacking. For the most part, lines developed from this backcross are low in vigor, have aerial roots, are bolting resistant, are poor seed producers, and generally are agronomically unattractive. Our recent releases, FC 708 and FC 708 CMS (BC_2), possess many of these same undesirable characteristics. However, since this is the first monogerm type O and CMS available with relatively good resistance to *Rhizoctonia*, it was considered worthwhile to release this germplasm and make it available to interested plant breeders for possible use in hybridizations.

A new technique for exposure to the pathogen of plants in both the vegetative and reproductive phase is described in a subsequent section of this report. This technique, hopefully, will be of value to breeders in the incorporation of resistance from some of our releases into some of their proven parents in hybrids.

The commercial-type materials listed in Table 2 are included for relative assessments and comparisons. Most of these represent commercial hybrids that we have not tested previously. Others represent exotic or antique germplasms as part of our continuing search for indigenous high levels of resistance. A considerable number of other germplasms were in the same test but are not included in the tables because they were not of significant interest.

Results and observations from our testing, selection, and breeding programs continue to support our hypothesis that resistance to root rotting

strains of *R. solani* is multigenically controlled in sugarbeet (at least two major genes with modifying genes or epistatic combinations). The resistance that we have developed appears to be horizontal since we know of no *Rhizoctonia* strain to which germplasm from our Fort Collins breeding program has been found to be susceptible.

Each year we produce new experimental hybrids involving our *Rhizoctonia*-resistant lines as parents. The performance of these hybrids is reported in another section of this report.

Table 1. Rhizoctonia root rot evaluation of multigerm resistant breeding lines and other lines for disease index (DI), % healthy roots, and % harvestable roots.

Entry no.	Line and description	DI	% healthy	% harvestable
246	FC 705	1.6	69	88
267	FC 705; increase	1.8	68	88
277	Syn 1 OP, from FC 702/5 X FC 701/5, F_2	1.8	60	92
269	M-line Syn from FC 702/5	1.8	60	87
329	M-line Syn from FC 701/5	2.0	59	84
323	Syn of 3 progenies from GW 674 & C 817	2.0	57	81
263	3rd cycle GH sel. from FC 703	2.1	53	81
248	FC 707	2.2	47	75
235	FC 704	2.3	53	82
247	FC 706	2.3	48	75
273	Syn from GW 674 & C 817	2.3	50	73
240	Syn 2 from 5 diverse Rhiz. resist. lines	2.3	38	77
238	Syn 1 from Phoma resist. sel. from FC701/4	2.4	43	78
257	FC 703; increase	2.4	44	74
305	FC 701/5	2.7	44	69
272	FC 702/5	2.8	42	63
250	FC 701/2	2.9	34	65
251	FC 702/2	2.9	37	60
284	Rhiz. dampoff resist. sel.	3.1	30	58
266	2 cy Rhiz. sel. from EL42	3.1	35	54
271	1 cy Rhiz. sel. from F1002	3.2	31	48
241	Syn 2 from FC 801	3.3	25	56
324	Syn 1 from (FC 901 X Rhiz.resist.)B_1P_1	3.7	21	44
276	2 cy Rhizoc. sel. from USSR lines	3.8	20	41
245	F1001; stor.rot resist. from USSR lines	5.7	3	9.2
249	FC 703; Rhizoc. resist. check	2.5	36	72
256	FC 901; Rhizoc. susceptible check	6.4	0	0
	LSD (.05)	0.65	11.5	11.2

Table 2. Rhizoctonia root rot evaluation of monogerm or segregating lines, and commercial type materials.

Entry no.	Line and description	DI	% healthy	% harvestable
	Monogerm or segregating			
261	Syn from 5 S_1's from (FC 701 X mm, TO)BC_1P_2	1.3	71	100
262	Syn from 18 S_1's from (FC 701 X mm,TO)BC_1P_2	1.3	76	97
260	OP from several MS S_1's	1.5	62	98
237	OP of aa segs. from Syn 1 from FC 701 X mm TO,F_2	1.5	69	91
236	Syn 1 from FC 701 X mm TO,F_2	1.7	61	89
308	Progeny from MS segs in mm Rhiz. resist. line	1.7	56	95
259	OP from 24 S_1's from (FC 701 X mm,TO)BC_1P_2	1.7	65	94
285	Rhiz. resist. mm non-TO	1.8	40	97
243	Syn 1 from (Rhiz. resist. X mm,TO)BC_1P_2	1.8	62	86
325	FC 708; Rhiz. resist.,mm, TO	2.0	45	89
258	OP from 5 S_1's from (Rhiz. resist.X mm,TO)	2.4	40	77
326	Syn 1 from SP5831-0	2.4	47	71
303	Syn 1 from (mm, TO X FC 701) $B_1P_1OP_1$	2.4	51	72
327	OP from Syn 1 from SP5831-0	2.7	41	61
239	Syn 2 from (mm, TO X FC 701)$B_1P_1OP_1$	4.2	17	34
264	FC 607 CMS	5.4	2	8
254	FC 606	5.7	3	10
255	FC 606 CMS	5.7	0	3
	Commercial-type materials			
253	EL 42	3.8	19	43
252	EL 43	4.7	8	22
290	B 525-50 L	4.8	13	27
302	HH 32	5.0	6	18
289	Am. 3-S	5.3	4	14
287	SP52108-0	5.4	1	11
296	Hacemo	5.4	4	16
299	Aula Dei 645(4X); Spain	5.5	2	11
309	Mono Hy AS	5.6	2	6
293	B 590	5.6	1	11
297	H 680 f	5.7	4	10
298	CERAMO	5.9	1	12
294	Mono Hy A3	6.1	0	1
295	Mono Hy A4	6.1	0	2
306	US 201	6.1	10	11
286	Am. 5	6.2	0	6
301	Polish (2X)	6.3	0	4
310	Mono Hy D7	6.3	0	3
311	HH 21	6.4	0	2
249	FC 703; Rhiz. resist. check	2.5	36	72
256	FC 901; Rhiz. susc. check	6.4	0	0
	LSD (.05)	0.65	11.5	11.2

Advanced Test of Experimental Hybrids Resistant to *Rhizoctonia solani*.--
R. J. Hecker and G. A. Smith.

Our greatest progress in breeding sugarbeet for resistance to root rot caused by *Rhizoctonia solani* has been achieved utilizing heterogeneous multigerm populations. In an effort to evaluate our multigerm Rhizoctonia resistant lines for general combining ability, we have crossed them with susceptible cytoplasmic male sterile lines. In evaluating these hybrids we have detected a few hybrids which display relatively good specific combining ability for sucrose production. We have tested these better hybrids in succeeding years. The results of these disease-free tests are summarized in Table 1.

Results for 1976 through 1978 were from single row plots in triple lattice tests. The results in 1979 were from a randomized complete block test with 5-row plots, 25 ft long, with rows 2, 3, and 4 being harvested. All the tests shown in Table 1 were grown under disease-free conditions at the CSU Agronomy Research Center and were planted between April 15 and April 27.

The results in Table 1 which indicate that some of the Rhizoctonia resistant pollinators have relatively good specific combining ability are significant, since the resistant pollinators had been developed essentially for resistance without regard to combining ability. The experimental hybrids are generally not significantly different than the check (Mono Hy D2) for recoverable sucrose or the sucrose yield components.

The disease indices (DI) from the 1979 Rhizoctonia nursery are also included in Table 1. Some of the hybrids have relatively good resistance, 6 out of 9 having significantly higher resistance than HH 32, a Rhizoctonia resistant commercial variety.

Some of these experimental hybrids might be directly useful in areas where rhizoctonia root rot is a chronic problem. Also, better hybrid combinations of these pollinators with other male steriles might be found, or the resistant pollinators might be selected for improved combining ability and used in some modified form.

Combining Ability Tests of Rhizoctonia Resistant Experimental Hybrids.--
R. J. Hecker and G. A. Smith.

In the 1979 combining ability test of Rhizoctonia resistant pollinators, we used a set of nine susceptible monogerm male sterile females and eight pollinators, seven of which were rhizoctonia root rot resistant and one of which was storage rot resistant. These test hybrids were grown in a disease-free test at the CSU Agronomy Research Center using single row plots in a triple lattice design.

The performance of the best individual hybrids is shown in Table 1 (see page C-13). Nine of the experimental hybrids were not significantly different than the check (Mono Hy D2) for recoverable sucrose. These are cases which

Table 1. Performance of experimental hybrids of Rhizoctonia susceptible CMS's and resistant pollinators grown disease free, and the 1979 disease index (DI).

Hybrid	79 DI	Recov. Sucrose (T/A) 79	78	77	76	$\bar{X}$[1]	Root yield (T/A) 79	78	77	76	$\bar{X}$[1]	Sucrose % 79	78	77	76	$\bar{X}$[1]	Thin juice purity % 79	78	77	76	$\bar{X}$[1]
FC603CMS X Syn of FC703	-	3.48	2.43	2.98		2.96	25.0	20.6	28.1		24.6	17.3	14.7	13.6		15.2	90.2	89.8	89.4		89.8
(100363CMS X 12166) X FC703(4X)	4.1	3.44	2.35	2.76	3.33	2.97	24.3	21.4	25.3	23.6	23.7	17.5	14.1	13.8	15.8	15.3	90.7	89.5	89.9	94.8	91.2
(562CMS X 546) X Phoma sel. from FC701/4	3.5	3.41	2.45	2.91		2.92	24.7	22.5	28.0		25.1	17.2	14.0	13.4		14.9	90.2	89.6	89.2		89.7
FC 3-way CMS X FC701/5	4.2	3.39	2.53	2.79	3.30	3.00	26.4	23.2	27.9	24.1	25.4	16.5	13.9	13.1	15.8	14.8	89.1	89.1	88.3	93.7	90.0
(FC504CMS X FC502/2) X FC705	3.9	3.34	2.29	2.96		2.86	24.7	20.1	27.4		24.1	17.0	14.5	13.9		15.1	89.1	89.8	89.1		89.3
FC 3-way CMS X FC703	4.4	3.30			2.42	2.86	24.5			22.5	23.5	16.9			15.9	16.4	89.9			94.9	92.4
(11866CMS X 12163) X FC703	5.1	3.27			2.82	3.05	22.7			19.9	21.3	17.6			15.7	16.7	90.9			95.0	93.0
(562CMS X 546) X FC703	4.8	3.26	2.64	2.88	3.43	3.06	23.7	24.4	25.8	25.0	24.7	17.1	14.0	13.8	15.5	15.1	90.1	90.0	90.5	94.4	91.3
FC505CMS X FC703(4X)	3.3	3.19	2.26	2.58	3.39	2.81	24.0	21.2	25.5	22.4	23.3	16.8	13.7	13.3	16.9	15.2	89.6	88.9	88.7	95.0	90.6
FC 2-way CMS X FC702/5	4.7	3.17	2.81	2.90	2.90	2.95	22.0	23.9	24.7	19.8	22.6	17.4	14.6	14.4	16.3	15.7	91.2	90.2	90.4	95.5	91.8
HH 32	5.3																				
FC703 Rhizoc. resist. check	2.6																				
Mono Hy D2; yield check	6.2	3.52	2.97	3.41	3.35	3.31	25.4	24.9	28.6	22.9	25.4	16.9	14.8	14.6	16.5	15.7	90.8	90.2	91.2	94.7	91.7
LSD (.05)	0.9	0.26	0.34	0.35	0.36		1.9	2.2	3.0	2.4		0.5	0.8	0.8	0.9		0.8	1.3	1.2	1.1	

[1] Those means involving less than 4 years cannot be compared directly with 4-year means.

Table 1. The most superior experimental hybrids in the 1979 disease free test of hybrids involving Rhizoctonia resistant pollinators.

Entry no.	Hybrid	Recov. sucrose (T/A)	Root yield (T/A)	Sucrose %	T.J. purity (%)
822	(642027s1 CMS X 662119) X FC 702/5 M-line Syn	3.30	27.5	15.4	89.0
812	(1861 CMS X 12166) X FC 702/5	3.19	25.0	16.0	89.8
826	(642027s1 CMS X 662119) X Syn progeny GW 674 + C 817	3.14	26.2	15.6	88.6
841	(652016s1 CMS X 662119) X FC 705	3.11	27.2	15.2	88.0
867	(562 CMS X 546) X FC 702/5 M-line Syn	3.10	24.4	16.0	89.7
806	(652016s1 CMS X 662119) X Syn from EL-42	3.09	24.6	15.9	89.6
837	FC 607 CMS X FC 705	3.05	25.3	15.9	88.3
871	(652016s1 CMS X 662119) X Syn progeny GW 674 + C 817	3.05	25.9	15.2	88.8
852	(FC 504 CMS X FC 502/2) X Syn from EL-42	3.04	23.3	16.2	89.8
801	(562 CMS X 546) X Syn progeny GW 674 and C 817	3.03	24.2	15.9	89.1
823	FC 3-way CMS X Syn progeny GW 674 and C 817	3.03	26.4	15.1	88.0
862	(562 CMS X 546) X FC 705	3.03	26.5	15.1	87.9
880	FC 3-way CMS X FC 702/5	3.00	22.6	16.4	90.5
805	FC 3-way CMS X FC 702/5 M-line Syn	3.00	22.2	16.7	90.5
858	(FC 504 CMS X FC 502/2) X Syn progeny GW 674 and C 817	2.99	24.1	15.9	89.4
816	(652016s1 CMS X 662119) X FC 703	2.98	25.1	15.3	88.4
842	FC 607 CMS X FC 702/5 M-line Syn	2.98	22.4	16.4	90.2
869	FC 3-way CMS X Syn 5 diverse Rh. lines	2.93	23.5	16.2	89.1
831	(562 CMS X 546) X Syn 5 diverse Rh. lines	2.90	25.1	15.3	87.6
863	(642027s1 CMS X 662119) X Syn 5 diverse Rh. lines	2.89	25.8	15.2	87.7
	Mono Hy D2 (check)	3.39	27.0	16.1	89.2
	LSD (.05)	0.35	2.5	1.0	1.6

had relatively good specific combining ability for root yield or sucrose content. Some of these better hybrids will be tested again in 1980. These better hybrids have relatively good production considering the relatively strong selection and breeding emphasis for Rhizoctonia resistance. Further information on these hybrids and limited quantities of seed are available to those who may be interested in testing them further. The CV's in this test were 10.1, 9.2, 5.1, and 1.54 for recoverable sucrose, root yield, sucrose %, and thin juice purity %, respectively.

A preliminary assessment of the general combining ability of these resistant pollinators is made in Table 2. The means of these hybrids with common pollinators are not a broad assessment of general combining ability, but the nine female parents involved have a certain amount of genetic diversity. We believe this array of means provides some indication of general combining ability of these pollinator lines. The FC 702/5 M-line synthetic would appear to have some potential as a pollinator, particularly because of the relatively high sucrose content of its hybrids. FC 705 produced high root yield hybrids with somewhat lower sucrose content and purity. This recent release, however, is the most resistant multigerm line that we have developed from our breeding program.

The disease resistance of these pollinators as assessed in the 1979 Rhizoctonia nursery is also shown in Table 2. The most resistant lines are FC 705 and FC 702/5 M-line synthetic. The storage rot resistant line, F 1001, was relatively Rhizoctonia susceptible.

The Rhizoctonia resistance of some of the more productive hybrids will be assessed in the Rhizoctonia nursery in 1980. Past experiments indicate that the rhizoctonia resistant pollinators should impart sufficient resistance when hybridized with susceptible females so that resulting hybrids should be potentially useful in rhizoctonia root rot problem areas.

Table 2. Means for sucrose yield and components of hybrids in which the respective Rhizoctonia resistant lines were pollinators (disease-free test in 1979), and disease indices (DI) of the pollinators in a 1979 Rhizoctonia inoculated test (0 = no infection; 7 = plant dead).

Resistant Pollinator	Disease index	Recov. sucrose (T/A)	Root yield (T/A)	Sucrose (%)	T.J. purity (%)
FC 702/5 M-line Syn	1.8	3.01	23.2	16.3	89.9
Syn progeny GW 674 and C 817	2.3	2.94	24.1	15.7	88.9
FC 702/5	2.8	2.90	22.5	16.2	89.9
FC 705	1.6	2.86	25.0	15.3	87.8
Syn from EL-42	3.1	2.79	22.6	15.7	89.3
FC 703	2.4	2.75	22.7	15.6	88.7
Syn 5 diverse Rh lines	3.1	2.71	22.6	15.7	88.8
F 1001 (storage rot resist.)	5.7	2.64	23.4	15.1	87.5

Rhizoctonia Resistance of Susceptible X Resistant Hybrids Relative to Their Parents.--R. J. Hecker and E. G. Ruppel.

The advanced experimental hybrids discussed in a preceding section of this report also were grown in the 1979 rhizoctonia nursery along with their parents for evaluation of their resistance to *Rhizoctonia solani*. In this experiment, we used single-row, 20-ft plots, and 4 replications in a randomized complete block design. The methods were described in the first part of this section on *Rhizoctonia* research.

The 10 hybrids listed in Table 1 were all developed from susceptible male sterile females pollinated by some of our most *Rhizoctonia*-resistant multigerm lines. The mean disease index of the hybrids at 4.2 is only slightly less than the mean of the mid-parent values at 4.4. Hence, there was very little dominance for resistance in this set of susceptible X resistant hybrids. The greatest degree of dominance was exhibited in the two triploid (3X) hybrids. This is similar to results which we have reported previously, that triploid hybrids with two genomes from the resistant parent tend to have a greater level of resistance. The eight diploid hybrids, as a group, had a DI of 4.3 compared to an average mid-parental value of 4.4. Hence, they showed very little dominance for resistance. This is somewhat in contrast to our past reports on similar hybrids where we had found some degree of partial dominance to be the general case. The disease intensity as measured by percentage harvestable roots reflected about the same type result as the disease indices.

At this point in time, until we get further results to clearly establish the effect of dominance, it appears that breeders should generally expect little dominance effects for resistance in hybrids involving susceptible diploid females and resistant diploid pollinators. With respect to triploid hybrids, the results in this experiment corroborate results from our earlier experiments in which there appears to be a dosage effect for resistance when a tetraploid resistant line is used as a pollinator in the hybrid.

Selection for Rhizoctonia Resistance Using Two Exposures to the Pathogen per Generation.--R. J. Hecker and E. G. Ruppel.

In our program of breeding for resistance to rhizoctonia root rot, we have always made selections for resistance following inoculation of vegetative plants grown in field plots. From various experiments, we know that the heritability for resistance to this disease is rather low, probably in the range of 0.25; hence the need has existed to apply greater selection pressure. In an attempt to accomplish this, we made selections of field-grown roots which had been inoculated by our standard procedure. After storing these selected mother roots over winter, they were transplanted and inoculated in seed-production isolations. As the individual bolting plants developed symptoms of infection, they were removed. In late June and early July, infection was at its peak. However, some plants flowered before showing symptoms of infection and contributed in some degree to the pollen cloud.

Table 1. Rhizoctonia resistance comparisons of experimental hybrids and their parents.

Hybrid	Disease Index				% Harvestable Roots			
	Hybrid	Mid-parent	Susc. female	Resist. male	Hybrid	Mid-parent	Susc. female	Resist. male
(11866CMS X 12163) X FC703	5.1	5.0	6.8	3.3	18	27	2	52
FC 2-way CMS X FC702/5	4.7	4.6	6.5	2.7	19	30	0	61
(562 CMS X 546) X Syn FC703	4.8	4.4	6.2	2.6	20	35	4	66
FC506 CMS X FC703(4X)	3.3	4.6	6.6	2.6	52	35	3	67
(100363 CMS X 12166) X FC703(4X)	4.1	4.7	6.7	2.6	33	33	0	67
FC 3-way CMS X FC701/5	4.2	4.3	6.3	2.3	31	37	3	72
FC 3-way CMS X Syn FC703	4.4	4.5	6.3	2.6	25	34	3	66
FC506 CMS X FC705	4.0	4.2	6.6	1.8	35	44	3	85
(FC504 CMS X FC502/2) X FC705	3.9	3.7	5.6	1.8	37	46	7	85
(562 CMS X 546) X Phoma sel. in FC 701/4	3.5	4.2	6.2	2.3	46	42	4	80
HH 32	6.0				17			
$\bar{X}$	4.2	4.4			32	36		
LSD (.05)	0.9				12			

By harvest time in early August, only that percentage of plants noted in Table 1 had remained infection free and survived the roguing process. At the time of seed harvest, the roots were lifted and the seed was pooled from those roots apparently infection free and from those roots which showed only a slight degree of infection. The 1978 isolation plot with the mix of five resistant sources had initially contained 338 plants, and the plot of FC 703 had contained 597 plants (Table 1). In the summer of 1979, resultant mass selections were evaluated in the rhizoctonia nursery. The results in Table 1 indicate that, in the case of FC 703, there was some indication of progress in resistance due to the combined selection in both vegetative and reproductive phases. It also appeared that there may have been more progress towards resistance in the portion of the populations that showed no infection at seed harvest time compared to the portion that showed a slight degree of infection.

Although this preliminary experiment did not clearly establish the value of exposure and selection in the reproductive phase, it is likely that selection pressure is greater in this phase than in the vegetative phase. In the case of FC 703, 30% of the population was selected after exposure in the vegetative stage; whereas, 5% was selected in the reproductive phase. Hence, less than 1% of the initial population was finally selected.

We are adopting this selection procedure on a broader scale and plan to use it routinely in our breeding program. The only disadvantage is the temporary contamination of the isolation plots, restricting their use in the near future to *Rhizoctonia*-resistant populations.

It is our recommendation that any breeder doing selection for *Rhizoctonia* resistance in segregating backcross generations start with sufficiently large populations that would allow two inoculation exposures per generation, and would allow up to 95% and 99% elimination in relatively resistant and susceptible populations, respectively.

Table 1. Rhizoctonia resistance assessments of sugarbeets exposed in the vegetative and reproductive stages.

Entry No.	Line and treatment	Parent plants selected	DI	% Healthy	% Harvestable
279	Mix of 5 resist. sources; no infec. after root inoculation	2%	1.9	52	82
280	Mix of 5 resist. sources; slight infec. after root inoc.	2%	2.8	35	64
281	FC 703; no infect. after root inoc.	3%	1.9	47	81
282	FC 703; slight inf. after root inoc.	2%	2.2	43	76
257	FC 703; no selection	--	2.4	41	74
	LSD (.05)		0.65	11.5	11.2

Effect of Soil Deposition in Sugarbeet Crowns on the Severity of Rhizoctonia Root Rot.--E. G. Ruppel and R. J. Hecker

A randomized complete block design with four replications was used to confirm last year's results (Sugarbeet Research, 1978 Report, p. C14-C15) which showed that soil deposited in beet crowns during cultivation practices led to increased root rot. General methods were described in the 1978 report, except no postemergence herbicide was applied.

Contrary to our previous results, crown deposition of soil did not increase disease severity in 1979 (Table 1). There was a tendency toward

Table 1. Effect of soil deposition in crowns of sugarbeet on severity of rhizoctonia root rot in 1978 and 1979.

Cultivar	Soil deposition[1]	Disease index[2]		% Harvestable[3]	
		1978	1979	1978	1979
FC 703	+	2.9	3.2	72	51
	-	2.3	3.1	78	54
HH 32	+	---	4.9	--	32
	-	---	5.1	--	30
FC 901	+	6.5	5.4	7	28
	-	5.2	5.1	27	30

[1] + = soil deposition into crowns; - = no soil in crowns.

[2] Disease index on a scale of 0 to 7, with 0 = no rot and 7 = plants dead. Means of eight replication in 1978 and four replications in 1979.

[3] Disease index classes 0, 1, 2, and 3 combined; means of eight replications in 1978 and four in 1979.

higher disease indexes and fewer harvestable roots when soil was thrown into crowns of both resistant line FC 703 and susceptible line FC 901, but differences were not significant. A reversal of this trend, also nonsignificant, was observed in the hybrid HH 32. Environmental influences and possible variations in inoculum potential may have contributed to the apparent year effect; however, we still cannot recommend any practice that deposits soil in beet crowns. The 1978 results, results of other investigators, and general observations have been too clear to be ignored.

(This study was partially supported by the Grower-G.W. Joint Research Committee, Inc.)

Effect of Systemic Insecticides on the Severity of Rhizoctonia Root Rot.--
E. G. Ruppel and R. J. Hecker

Manzate-treated seed of *Rhizoctonia*-resistant line FC 703 and an intermediately resistant commercial hybrid HH 32 were planted in *R. solani*-infested and inoculated soil on April 20 in a randomized complete block design with three replications. Four-row plots were 20 ft long with 22 inches between rows. Plots were thinned to 25 plants/row on May 24. On June 1, carbofuran 10 G ('Furadan') at 20 lb product/acre, aldicarb 15 G ('Temik') at 15 lb product/acre, and phorate 10 G ('Thimet') at 15 lb product/acre were side-dressed and covered. Nontreated plots of each cultivar served as controls. Roots were harvested in September and rated for rot on a scale of 0 to 7, with 0 = no rot and 7 = plants dead. A disease index (DI), a weighted average based on the number of plants in each class, was calculated for each plot. Percentage healthy data was calculated by combining DI classes 0 and 1. Results are presented in Table 1.

Table 1. Effect of three systemic insecticides on severity of rhizoctonia root rot in sugarbeet.

Cultivar	Insecticide	Disease index[1]	% Healthy[2]
FC 703	Furadan	4.1	24
	Temik	3.5	35
	Thimet	4.6	18
	None	2.9	44
HH 32	Furadan	4.5	25
	Temik	5.2	14
	Thimet	5.5	9
	None	4.2	29

[1] Disease index on a scale of 0 to 7, with 0 = no rot and 7 = plants dead means of three replications.

[2] Disease index classes 0 and 1 combined; means of three replications.

Analyses of variance for DI and % healthy data indicated significant differences among insecticides, but there were no significant line X insecticide interactions ($P = 0.05$). A Duncan's multiple range test (DMRT) on the DI means (across lines) showed that 'Thimet' significantly increased root rot severity, as compared with the other insecticides and the control. A DMRT on the % healthy means (across lines) showed that all the insecticides significantly reduced % healthy beets as compared with the controls. The common use of 'Thimet' in the control of curly top, and 'Temik' for nematode control warrants additional studies on the effect of these and other pesticides on rhizoctonia root rot.

(This study partially supported by the Grower-G.W. Joint Research Committee, Inc.)

Effect of Nitrogen Source and a Nitrogen Stabilizer on Rhizoctonia Root Rot of Sugarbeet.--R. J. Hecker and E. G. Ruppel

We have shown in previous research that rhizoctonia root rot of sugarbeet was not appreciably affected by the quantity of available nitrogen in the soil, or by the time or method of nitrogen application. Research by others has demonstrated various effects of nitrogen form on several fungal and bacterial diseases of other crops. In our continuing research to identify cultural factors affecting rhizoctonia root rot in beet, we conducted a field experiment in 1979 using two forms of fertilizer nitrogen and a nitrification inhibitor, nitrapyrin ('N-SERVE 24'). Nitrapyrin is specifically active as a suppressant of *Nitrosomas* species, the soil bacterium responsible for the rapid conversion of ammonium to nitrite nitrogen. This allowed a comparison of nitrogen forms on rhizoctonia root rot.

In an area of our 1978 *Rhizoctonia* nursery, the rotted roots were plowed down in the fall. In the spring of 1979, 50 lb/acre of dry, ground, barley-grain inoculum of *R. solani* was preplant broadcast and incorporated as well as 3 lb active ingredient (a.i.) of cycloate ('Ro-Neet') per acre. The two nitrogen treatments, 100 lb N/acre each of ammonium sulfate and calcium nitrate, and the nitrapyrin treatment, 2 lb a.i./acre also were preplant broadcast and incorporated. A soil test detected about 90 lb/acre of residual nitrate N in the top 2 ft of soil.

The experiment was a 2 X 3 X 2 factorial in a randomized complete block design with three replications, planted April 20. The two cultivars used were Mono Hy A1 (susceptible) and an intermediately resistant experimental hybrid. The 4-row, 20-ft plots were thinned to 25 plants/row on June 24. Roots in all plots were lifted on Sept. 21 and rated for amount of rot, with 0 = no infection and 7 = plant dead. The disease index (DI), a weighted average based on the number of plants in each class was calculated for each plant. There was no difference between the two center rows (2 and 3), and rows 1 or 4; hence, all rows of each 4-row plot were used to calculate the DI's and % harvestable roots. The percentage harvestable roots were those roots rated 0, 1, 2, and 3; these roots were sufficiently sound to be included in a grower's harvest.

Treatment means are given in Table 1. No significant differences were measurable between the two nitrapyrin treatments across nitrogen treatments, or between nitrogen treatments. None of the first order interactions were significant.

The DI's for nitrapyrin vs. no nitrapyrin on the calcium nitrate treatment (3.9 vs. 4.8) were significantly different, but this cannot be due to nitrification inhibition. There were significant entry differences, with Mono Hy A1 having DI and % harvestable means of 4.9 and 32, respectively, compared with the intermediately resistant hybrid with means of 3.7 and 48.

There was a relatively large amount of residual nitrogen in the soil in the form of nitrate N (90 lb/acre). Hence, in the calcium nitrate treatment, about 190 lb N/acre were available from planting as nitrate N, whereas about 90 lb N/acre as nitrate N and 100 lb N/acre as ammonia N were present in the ammonium sulfate treatment. The nitrapyrin would be expected to have reduced the nitrification rate of the ammonium N, and its effect would be

expected to have lasted for more than 100 days after application. Hence, some difference in nitrogen form should have persisted well into the time of infection and disease initiation. We conclude, therefore, that root rotting strains of *R. solani* are probably unaffected by proportions of N forms which might be practically achievable in normal beet culture.

Table 1. Mean disease index (DI) and % harvestable roots for nitrogen and nitrapyrin treatments.

Nitrogen treatment	Nitrapyrin		No nitrapyrin		Means	
	DI	% har.	DI	% har.	DI	% har.
Ammonium sulfate	4.3	40	4.7	36	4.5	38
Calcium nitrate	3.9	45	4.8	34	4.3	40
No added nitrogen	4.3	41	3.9	45	4.1	43
Means	4.2	42	4.5	38		

Effect of Plant Population Density on Severity of Rhizoctonia Root Rot.--E. G. Ruppel and R. J. Hecker

We tested whether sugarbeets spaced 5-, 10-, and 15-inches within the row responded differently to our standard inoculation procedures. Single-row plots 20-ft long of *Rhizoctonia*-resistant line FC 703 and an intermediately-resistant hybrid were separated by one row of a resistant common competitor. A randomized complete block design with four replications was used.

Analyses of variance of disease index and % healthy data indicated no significant differences in the severity of root rot among the spacing treatments. The difference between lines in both analyses was highly significant, with less rot in line FC 703. There were no significant lines X spacing interactions. Means are presented in Table 1.

Table 1. Effect of plant population density on severity of rhizoctonia root rot in sugarbeet.

Line	Plant spacing	Disease index	% Healthy
	(in)		
FC 703	5	2.6	36.9
	10	3.0	33.4
	15	2.9	30.4
Hybrid	5	4.4	3.0
	10	4.7	2.4
	15	4.4	5.8

Organic Amendments for Control of Rhizoctonia Damping-Off in Sugarbeet.--
E. G. Ruppel and R. J. Hecker.

Dry, ground barley straw, alfalfa hay, pine sawdust, and pure cellulose was added to *Rhizoctonia*-infected field soil at 0, 0.25, 0.5, or 1.0% of the soil dry weight. The soil was infested with *R. solani* (isolate R-9) by mixing dry, ground barley-grain inoculum at either 500 or 1,000 ppm. Nonamended infested soil was used as a control. The various soil mixes were placed in 10-cm-diam clay pots, and maintained at 50% maximum water holding capacity for 2 weeks, after which each pot was planted with 10 seeds of commercial cultivar Mono Hy D2. Thereafter, the soil in each pot was irrigated as needed. Seedling survival, as a percentage of control survival, was recorded 21 days after planting. To determine residual effects of the amendments and/or the development of pathogen antagonists, all seedlings were harvested and 10 more seedlings were planted immediately in each pot. Similarly, a third planting was made after the results of the second planting were recorded. A split-plot design was used with three replications of each treatment

Results (Table 1) showed a general trend of increased seedling survival with an increase in concentration of organic amendment, with additional increases after each planting. There were some exceptions to this trend, particularly at the higher fungus level. Barley straw at 1.0% provided the greatest control (2.5 times control survival) after the third replanting in the lower level of fungus inoculum.

All percentages below 100% in Table 1 indicate that the amendments actually contributed to an increase in seedling damping-off. These increases could be due to a direct adverse effect on seed germination, an indirect adverse effect on antagonists of *R. solani*, or a direct stimulatory effect on the pathogen. Additional studies are needed to clarify this point.

The values greater than 100% indicate control of *R. solani*. Since this effect was not observed in a preliminary test with sterile soil, and tended to increase in time and concentration of amendments, a biological control mechanism seems likely. Bioassays of soil dilutions on a selective medium indicated that *Trichoderma*, a known antagonist to *Rhizoctonia*, was not involved. However, additional tests are needed before this fungus can be ruled out.

With only three exceptions, alfalfa hay amendments led to an increase in damping-off. Since many observations have been made of increased rhizoctonia root rot in beets following alfalfa, additional studies are needed on the effect of this amendment on the pathogen or its antagonists.

(This study was partially supported by the Grower-G.W. Joint Research Committee, Inc.)

Table 1. Effect of organic amendments at three concentrations on seedling survival of sugarbeet after three successive tri-weekly plantings in field soil infested with 500 ppm (L) or 1,000 ppm (H) barley-grain inoculum of *Rhizoctonia solani*.

Organic amendment		Seedling survival at indicated planting[2]					
		1		2		3	
Type	Concn[1]	L	H	L	H	L	H
	%	%	%	%	%	%	%
Barley straw	0.25	21	76	92	89	85	103
	0.5	60	158	100	143	100	213
	1.0	103	158	196	108	245	201
Alfalfa hay	0.25	34	29	90	34	91	27
	0.5	69	46	65	21	27	38
	1.0	72	79	100	97	110	142
Pine sawdust	0.25	21	36	3	31	12	130
	0.5	2	102	112	93	79	205
	1.0	29	53	146	85	102	103
Cellulose	0.25	68	61	110	89	100	153
	0.5	101	101	159	98	114	122
	1.0	113	120	99	124	111	235

[1]Concentrations as % dry weight of soil.

[2]Percentages based on control survival in nonamended, *Rhizoctonia*-infested soil; means of three replications. Data recorded 21 days after each planting.

EPIDEMIOLOGICAL AND BIOLOGICAL INVESTIGATIONS ON FUSARIUM YELLOWS OF SUGARBEET (BSDF Project 54)

Inoculations of Sugarbeet with Fusarium in the Greenhouse.--E. G. Ruppel.

Soil infested with spore suspensions of Oregon, Wyoming, and Colorado isolates of *Fusarium oxysporum* f. sp. *betae* was placed in 4-in-diam pots and planted with seeds of a *Fusarium*-resistant and a susceptible line of sugarbeet (supplied by the G.W. Sugar Company). Emerging seedlings were not uniformly infected by any isolate, and differences in host resistance or isolate virulence could not be detected. Obviously, conditions for a more uniform epiphytotic must be established, along with techniques that allow differentiation among genotypes having varied degrees of resistance to the pathogen.

When roots of 2-month-old sugarbeets were wound-inoculated with a known pathogenic Oregon isolate, symptoms of fusarium yellows developed slowly over a 2-month period. The long incubation period and the need for large, individually potted beets would not make such a test suitable for evaluating large populations for resistance to the pathogen.

Further In Vitro Comparisons of Several Fusarium Isolates.--E. G. Ruppel.

Isolates from Colorado, Montana, and Wyoming were somewhat similar in culture, particularly in pigmentation of mycelium and culture medium. Isolates from Oregon, however, were strikingly different in these characteristics from those obtained from other states.

SUGARBEET QUALITY IMPROVEMENT RESEARCH (BSDF Project 53)

Clarification of Samples for Polarimetric Sucrose Determination: A Detailed Comparison of Aluminum Chloride vs. Lead Subacetate.--S. S. Martin and R. J. Hecker.

Because of current interest in an alternative to lead as a clarificant for sugarbeet extracts for polarimetric sucrose determination, we report here in greater detail the results of an experiment based on diverse experimental material. Previous reports have described the analytical procedures (Sugarbeet Research, 1977 Report) and the overall means of this experiment (Sugarbeet Research, 1978 Report).

The experiment was designed to obtain a wide range in sucrose concentration, so that the effectiveness of aluminum chloride as a clarificant could be compared with that of lead subacetate over a more extensive range than would be encountered in any normal commercial growing situation. Four entries and two nitrogen levels provided the variability desired.

As we reported previously (Sugarbeet Research, 1978 Report, p. C24), the overall experimental means for aluminum-clarified vs. lead-clarified samples were 14.70 and 14.73, respectively. The two filtrate types did not differ statistically (by paired-sample t-test, $t=1.72$) and the correlation coefficient between sample types was very high ($r=0.99$).

Examination of the means by entry (across both nitrogen levels) showed that only in the half-fodder beet, low sucrose genotype was there a significant difference between the two filtrate types. Here, the aluminum-clarified samples were slightly lower in sucrose content than the comparable lead-clarified samples (Table 1). Even in this entry, if the samples were considered as a group, the differences between filtrate types were not statistically significant. Only by the more sensitive two-way or paired analysis were differences apparent statistically. The correlation

coefficient between the two filtrate types for the half-fodder beet entry was 0.98, so samples corresponded closely except for the slightly higher sucrose values, on average, of the lead-clarified samples.

In each other genotype, either method of clarification resulted in sucrose data that did not differ statistically, either by groups or by paired analysis (Table 1).

Table 1. Sucrose means by entry, for samples clarified by aluminum chloride or lead subacetate. [n = 72 samples per entry per extract type.]

Entry	Mean		Group t	Paired t
	Pb-clarified	Al-clarified		
52-305 CMS X Ovana, F1	11.58	11.44	0.74 ns	4.86**
Polish AJ-ZZ	16.82	16.84	0.16	0.53
Mono Hy D-2	15.41	15.41	0.04	0.16
FC Exptl hybrid	15.12	15.13	0.16	0.85

If the sucrose data were examined at each level of applied nitrogen, "regular" and "high," the usual effect of excess nitrogen application was seen (Table 2). Both clarification methods, however, gave similar results.

Table 2. Sucrose means by nitrogen level, for samples clarified by aluminum chloride or lead subacetate.

N-LEVEL	Mean		Group t	Paired t
	Pb-clarified	Al-clarified		
Regular N	14.93	14.89	0.15	1.86
High N	14.53	14.52	0.07	0.73

We conclude that aluminum chloride clarified samples are fully satisfactory for polarimetric sucrose determination in any sugarbeet genotypes likely to be encountered in commercial practice.

Effects of Mass Selection for Amino Nitrogen Content.--R. J. Hecker, S. S. Martin, and G. A. Smith.

Several years ago we commenced an experiment on mass selection for amino nitrogen content in sugarbeet. The objectives in this experiment were (1) to determine the effects of amino N selection on sugarbeet quality and yield and (2) to make determinations about the genetic control of amino N content based on the response to selection.

The source population from which the initial selections were made was a productive, genetically broad based, monogerm, open pollinated population. The selection study began with four directions: (1) selection for low amino nitrogen at high nitrogen fertility, (2) selection for high amino N at high fertility, (3) selection for low amino N at low fertility, and (4) selection for high amino N at low fertility. Two cycles of selection were completed in all four categories. Thereafter, limited resources necessitated the abandonment of selections being made at low fertility. The selections at high fertility were carried forward with four cycles being completed for low amino N and three cycles for high amino N. One selection cycle of the latter was lost by accidental herbicide application. Seed produced in these various cycles of selection, along with the source population, were grown at Fort Collins under optimal nitrogen fertility. The results of this assessment are shown in Table 1.

In those populations of principal interest, low and high amino N at high N fertility, it appears that genetic progress was made toward lower amino N content in raw juice, as the fourth cycle had 1.0 mg of amino N per 100 g sucrose in raw juice compared with 1.5 mg in the source population. More dramatic selection results were apparent in the selection in the opposite direction (high amino N), with the third cycle having 2.9 mg of amino N per 100 g sucrose in raw juice compared to 1.5 mg in the source population. Total nitrogen per 100 g sucrose in raw juice appeared to have decreased or increased in concert with the amino N content. The content of nitrate, sodium, and potassium appeared to have been unaffected by the amino N selection in either direction, and betaine appeared to have been slightly affected. Selection for low amino nitrogen appeared to have a deleterious effect on recoverable sucrose and sucrose content, with root yield and purity being relatively unaffected. In the high amino N selection at high N fertility, the thin juice purity appeared to have been significantly decreased. In general the selection for low amino N content was deleterious to sucrose production, although significant improvement was shown in thin juice purity. From these preliminary results it would appear that selection for low amino N *per se*, even though effective in diminishing the quantity of amino N in the resulting selective populations has not been beneficial to sucrose production.

Lead clarified sucrose filtrate was also collected and analyzed from these various populations and, although there were absolute differences in the values, the results due to this selection were quite similar.

Another field test of these materials along with combining ability tests of these lines as pollinators will be accomplished in 1980 and complete results will be reported later.

Table 1. Raw juice and sucrose yield components in succeeding generations of selection for amino nitrogen content.

Entry		Amino N	Total N	NO_3	Na	K	Betaine	Recov. sucrose	Root yield	Sucrose	Thin juice purity
		---- (mg/100 sucrose in raw juice) ----						---(kg/plot)--		%	%
923	Source pop.	1.5	7.9	7.3	3.0	5.8	17	1.71	14.1	14.8	91.3
922	1 cy low AMN, high fert.	1.3	6.8	5.6	2.6	4.9	15	1.62	13.3	15.0	92.2
920	2 cy low AMN, high fert.	1.2	6.8	4.8	2.7	5.3	15	1.69	14.1	14.8	92.2
919	3 cy low AMN, high fert.	1.1	6.6	7.9	3.5	5.7	15	1.77	15.3	14.3	91.4
918	4 cy low AMN, high fert.	1.0	6.2	6.7	3.5	5.0	14	1.53	13.5	14.0	92.0
926	1 cy high AMN, high fert.	1.6	8.1	8.1	3.7	6.0	17	1.67	14.0	14.7	90.8
925	2 cy high AMN, high fert.	1.9	8.3	4.7	3.1	6.0	18	1.73	14.3	14.9	91.0
924	3 cy high AMN, high fert.	2.9	10.6	4.8	3.0	6.6	16	1.72	14.3	15.0	89.8
928	1 cy high AMN, low fert.	1.9	8.3	5.6	2.8	6.3	19	1.7	14.0	15.2	90.8
927	2 cy high AMN, low fert.	1.8	8.6	5.7	2.7	6.6	18	1.8	14.5	15.2	91.1
929	2 cy low AMN, low fert.	1.4	7.4	10.0	4.8	5.8	15	1.84	16.0	14.2	90.8
930	Mono Hy D2	1.6	7.2	4.5	2.3	5.1	16	2.02	16.3	15.3	92.4
	LSD (.05)	0.26	0.87	1.94	0.81	0.66	1.8	0.12	0.96	0.44	0.62

Effect of Selection for Post-Storage Quality.--R. J. Hecker, S. S. Martin, and G. A. Smith

Two cycles of a post-storage quality selection experiment have been completed. The objective of the experiment was to determine the effectiveness of quality selection after 100 days of post-harvest storage. Preliminary results are presented here as a progress report. The source population in this experiment was SP 6322-0, a genetically broad based multigerm population which is the male parent of the commercially used hybrid, USH 20. Individual roots were then analyzed for weight and sucrose content and for amino nitrogen, sodium, and potassium in lead-clarified sucrose filtrate. From these non-sucrose constituents and the sucrose, a calculated purity was determined. Selections of individual roots were made on this calculated purity. The selected individuals were then inter-mated to produce the population for the next cycle of selection. The first and second cycle populations from optimum and high fertility were grown together with the source population at optimum fertility at Ft. Collins.

The results from beets at harvest are shown in Table 1. The chemical analyses were made in raw juice in order to measure the selection effect directly on the beets. This mass selection for post-storage quality apparently was effective in the improvement of thin juice purity, especially in the selected population grown at optimum fertility. The second cycle population had a thin juice purity of 93.4% compared to 91.3% for its source population. Sucrose in the populations developed from selection was not significantly different from that of the source population; however, the root yields of all selected populations were reduced from that of the source population, and recoverable sucrose tended to be lower in selected populations. There were no significant changes in amino nitrogen, total nitrogen, potassium, or betaine, but nitrate and sodium were significantly lower in both second cycle populations.

Even though thin juice purity and sucrose were significantly increased in the second cycle populations, root yield decreased. This loss in root yield *per se* may be unimportant if the combining ability of the selected populations was not affected. We plan to continue the experiment through one or two additional cycles of mass selection for post-storage quality, then assess the source and selected populations for combining ability.

Table 1. Quality, yield, and chemical characters in raw juice of progenies of quality selections.

Entry	Thin juice purity	Sucrose	Root yield	Recov. sucrose	Amino N	Total N	Nitrate	Na	K	Betaine
	(%)	(%)	--(kg/plot)---		---- (mg/100 ml of raw juice) -------					
934 SP 6322-0 (source)	91.3	14.0	13.0	1.47	22.8	113	110	57	81	228
933 1 cy sel. at opt. fert.	91.4	13.8	11.8	1.32	22.1	111	126	61	75	227
931 2 cy sel. at opt. fert.	93.4	15.0	11.4	1.40	19.1	113	65	37	71	232
937 1 cy sel. at high fert.	91.9	14.4	11.6	1.35	24.3	122	111	53	79	215
935 2 cy sel. at high fert.	92.4	14.9	10.2	1.23	23.9	123	88	44	79	230
LSD (.05)	0.6	0.4	0.82	0.10	3.7	14	22	9	10	22

CERCOSPORA/CURLY TOP RESISTANCE BREEDING AND RELATED RESEARCH

(BSDF Project 25)

Breeding for Resistance to Cercospora and Curly Top Virus, 1979.--G. A. Smith and E. G. Ruppel

The leaf spot epidemic in our 1979 nursery provided excellent conditions for evaluation of breeding lines. Under the severity of this year's epiphytotic, a leaf spot rating of 4.0 at the peak of the epidemic would be considered good. The average rating of our leaf spot resistant check in 1977 and 1978 was 4.6 and 3.0, respectively. The average resistant check rating in 1979 was 3.8. The curly top epidemic at Logan, Utah was considered moderate and, hence, many of the curly top ratings reported here would be greater under a more severe epidemic.

The results of 1979 leaf spot and curly top epidemics are presented in Table 1. The majority of lines in Table 1 have been developed for combined resistance to leaf spot and curly top. As emphasized before, this is an exceedingly difficult goal because of an apparent negative association between the two diseases. FC 606 (entries 1281 and 1282) followed by FC 607 (entry 1296) are the latest of only a very few that successfully combine good levels of resistance to both diseases and have good vigor. Recent data suggest that these lines have good combining ability for root yield and sucrose. Certain hybrid combinations with these lines also may be especially good for disease resistance. Entry number 1311 is one such cross that has high leaf spot resistance, and yields well under *Cercospora* infection according to our initial test results. Another monogerm combination that has good combined resistance is entry 1301. If this entry continues to show good combined resistance, the synthesis of its type 0 will be undertaken in the greenhouse.

Table 1. Mean leaf spot and curly top ratings of some breeding lines tested at Fort Collins, CO and Logan, UT, 1979.

Entry No.	Seed No.	Description	Leaf spot [1]	Curly top [1]
1280	781005HO	(642027s1 CMS X 662119s1, T.O.) X FC 605, T.O. = FC 608	4.5	2.0
1281	A78-44	(662119s1 CMS X 652016s1, T.O.) X FC 605, T.O. = FC 606 T.O.	4.0	2.5
1282	A78-45	[662119s1 T.O. X 652016s1 CMS (B_4)] X FC 605 T.O. = FC 606 CMS	4.2	2.0
1283	781040	741026H ♀ seed of roots sel. for hi sucr. and intercrossed with roots selected for high LSR and reselected for LSR	4.7	3.0
1285	781042H	Bulk of 761046H2 + 761046H from 741026H2; intercrossed with selections for high LSR and high sucrose	4.7	3.5
1286	781043H	761047H2; 741023. FC 605 sel. for high sucrose $\sqrt{4}$th root and high LSR	4.5	4.5
1287	781051H02	(652016s1 CMS X 662119s1, mm, T.O.) X 1861 T.O., mm	5.7	2.5
1288	781051H03	(642027s1 CMS X 662119s1, mm, T.O.) X 1861 T.O., mm	6.0	2.5

--Contd.--

Table 1. Mean leaf spot and curly top ratings . . . . .Continued.

Entry No.	Seed No.	Description	Leaf spot[1]	Curly top[1]
1289	781051HO4	FC 605 CMS X 1861 T.O., mm	4.7	2.0
1290	781051HO5	(FC 504 CMS X FC 502/2) X 1861 T.O., mm	4.3	4.5
1291	781090HO2	[(652016s1 CMS, B_4, X 662119s1, T.O.) X FC 605 T.O.] X 1861, T.O., mm	5.2	3.0
1292	781090HO3	[(FC 504 X 502/2-CMS) X FC 605 T.O.] X 1861, T.O., mm	5.7	3.0
1293	781090HO4	(FC 506 CMS X FC 605 T.O.) X 1861, T.O.,mm	4.3	4.0
1295	751102HO3	(642027s1 CMS X 662119s1, T.O.) X FC 605, T.O. = FC 608 CMS	4.5	2.0
1296	751102HO4	FC (504 X 502/2) CMS X FC 605, T.O. = FC 607 CMS	4.5	3.5
1297	751102HO5	FC 506 CMS X FC 605, T.O.	3.8	3.5
1298	751105HO2	(652016s1 CMS X 662119s1, T.O.) X FC 506 TO	4.5	3.5
1299	75119H3	FC 605 CMS X LSR intercrosses from *B. maritima* and *B. vulgaris*	4.5	2.0
1300	751124HO1	662119s1 CMS (B_4), mm, LSR-CTR	5.0	1.5
1301	751124HO2	FC (504 X 502/2) CMS X 662119s1, T.O., mm	4.0	3.5
1302	761029H2	[FC (504 X 502/2) CMS, mm X FC 605 T.O.] X 761016H, MM, non-O	3.7	3.0
1303	761029H3	(FC 506 CMS X FC 605) X 761016H, MM, non-O, LSR	4.0	3.5
1304	761029H4	FC 605 CMS X 761016H, MM, non-O, LSR	4.3	2.5
1305	761030H2	[FC(504 X 502/2) CMS X FC 605] X 761017, MM, non-O, LSR	4.2	2.5
1306	761030H3	(FC 506 CMS X FC 605) X 761017, MM, non-O, LSR	4.2	3.0
1307	761034H3	[(652016s1 CMS X 662119s1, T.O.) X FC 605, T.O.] X 761034H, MM, LSR	4.3	3.0
1308	761036HO3	FC 602 CMS X 761036HO, mm, from 662110s1, CTR-LSR	4.3	2.5
1309	761036HO5	FC 605 CMS X 761036HO, mm, from 662110s1, CTR-LSR	3.8	1.5
1310	761036HO7	FC 506 CMS X 761036HO, mm, from 662110s1, CTR-LSR	4.0	3.5
1311	761039HO2	FC 605 CMS X [FC(504 X 502/2) X SP 6322-0]= FC 607 CMS X SP 6322-0	3.3	3.0
1313	771058HO4	(652016s1 CMS X 662119s1, T.O.) X FC 604,TO	4.8	3.0
1314	771060H	FC 801, MM, RR	5.7	4.5
1315	771060H2	FC 605 CMS, mm X FC 801, MM	4.5	4.0
1316	771060H3	662119s1 CMS, CTR, mm X FC 801, MM	5.3	3.5
1317	771060H5	(642027s1 CMS X 662119s1, T.O.) X FC 801,MM	5.2	4.5
1318	771060H6	(652016s1 CMS X 662119s1, T.O.) X FC 801,MM	4.8	4.0
1319	771081HO2	(642027s1 CMS X 662119s1, T.O.) X L-36, mm, CTR	6.0	1.5
1320	771081HO3	(652016s1 CMS X 662119s1, T.O.) X L-36, mm, CTR	5.3	1.0
1321	69-9432	34 CMS; MM, CTR	7.0	1.0
1322	69-9433	34 T.O.; MM, CTR	7.0	1.5

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Table 1. Mean leaf spot and curly top ratings . . . . .Continued.

Entry No.	Seed No.	Description	Leaf spot	Curly top[1]
1323	771031H	Syn 1 of FC 701 X (LSR-CTR, mm, T.O. lines)	4.8	5.5
1324	761051	Rh. res. syn from FC 901 X 631001-0,B_1P_1	6.0	4.5
1325	771097HO	Rh. res. mm T.O.	4.5	5.5
1326	761058H-1 thru -26 comp	Syn 1 of FC 701 X (LSR-CTR, mm, T.O. lines)	4.5	5.5
1327	771077	US 201	3.3	5.5
Checks:				
1328	671201HO8	LSR check; FC (504 X 502/2)X SP 6322-0	3.8	5.0
1329	A63-5	Intermediate LSR check; SP 5822-0	4.3	5.5
1330	731083	LSS check; synthetic check	6.8	5.5
	US 41	Logan check		3.2
	US 33	Logan check		5.0

[1] Leaf spot and curly top ratings based on 0-10 scale with 0 = no symptoms and 10 = dead for curly top or complete defoliation for leaf spot.

Leaf Spot Evaluations of Sugarbeet Lines Submitted by BSDF-Member Companies.--E. G. Ruppel and G. A. Smith.

Separate randomized complete block designs with two replications were used to evaluate a total of 116 breeding lines submitted by American Crystal, Great Western, and Holly Sugar Companies, and from Beta Seed, Inc., for their response to infection with *Cercospora beticola*. Internal check lines included *Cercospora*-resistant FC(504 X 502/2) X SP 6322-0, a susceptible synthetic, and SP 5822-0 having intermediate resistance to *Cercospora*. The nursery was planted April 24 and inoculated July 9. The epidemic developed and remained exceptionally uniform, reaching maximum severity about September 4. Warm weather and abundant precipitation provided a severe epidemic. We made ratings for leaf spot on August 22, August 28, and September 4, using our usual 0 to 10 scale. Mean ratings for the resistant check ranged from 2.8 to 4.3 (overall mean = 3.5) across all tests, whereas the susceptible check ranged from 6.8 to 8.0 (overall mean = 7.4). The intermediate check ranged from 3.0 to 4.8 (overall mean = 3.9). Company lines ranged from 1.8 to 8.0 across dates of rating, and from 3.5 to 8.0 on the last date of rating. Results of the individual tests were tabulated and sent to each respective contributor.

The Development and Release of FC 607 and FC 607 CMS.--G. A. Smith

FC 607 was developed from the cross of FC (504 X 502/2) CMS X FC 605 T.O. All three of these component lines are monogerm and have resistance to cercospora leaf spot. FC 605, released in 1978, was developed for combined resistant to *Cercospora* and the curly top virus. FC 605 represents 50% of the genes in both FC 607 T.O. and FC 607 CMS.

FC 607 has shown levels of resistance to *Cercospora* and *Cercospora*/curly top not seen in the parental components or in any other monogerm lines developed or evaluated at Ft. Collins. The average disease resistant evaluations for FC 607 from 1976 through 1979 are presented in Table 1.

Table 1. The 4-year mean (1976 through 1979) leaf spot and curly top ratings of FC 607, and resistant and susceptible checks.

Entry	Leaf spot	Curly top
FC 607	3.5	4.0
LSR check	3.6	5.0
LSS check	6.8	5.5
US 41	---	4.3
US 33	---	5.6

Yield response of FC 607 under severe leaf spot was determined in 1979 and results are presented in Table 2. Under these rather severe leaf spot conditions, FC 607 yielded more gross sucrose than the other selected crosses.

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Table 2. Yield of FC 607 and several other experimental disease resistant crosses under severe Cercospora epidemic at Ft. Collins, 1979.

Entry No.	Description	Root weight	Sucrose	Leaf spot	Curly top	Gross sucrose
		(T/A)	(%)			(lb/A)
1281	(662119s1 CMS X 652016s1,T.O.) X FC 605, T.O. = FC 606 T.O.	19.67	14.10	4.0	2.5	5547
1282	[662119s1 T.O. X 652016s1 CMS (B_4)] X FC 605 T.O. = FC 606 CMS	18.34	14.52	4.2	2.0	5326
1295	(642027s1 CMS X 662119s1, T.O.) X FC 605,T.O. = FC 608 CMS	16.37	14.86	4.5	2.0	4864
1296	FC(504 X 502/2) CMS X FC 605, T.O. = FC 607 CMS	19.67	16.11	4.5	3.5	6337
1311	FC 605 CMS X [FC(504 X 502/2) X SP 6322-0] = FC 607 CMS X SP 6322-0	21.41	14.48	3.3	3.0	6201
1328	LSR check, FC(504 X 502/2) X SP 6322-0	20.52	14.69	3.8	5.0	6029
1329	Intermediate LSR check; SP 5822-0	19.57	12.79	4.3	5.5	5006

Entry 1311 was very vigorous, had a low leaf spot rating, and was expected to out-yield the other entries. However, the severe leaf spot apparently reduced sucrose % and, consequently, gross sucrose.

The combining ability of FC 607 for yield has not been extensively studied, but results under nondisease conditions have indicated good combining ability for root weight and sucrose.

In 1980, the yield performance of 12 hybrid combinations of FC 607 was evaluated under disease-free conditions at Fort Collins. The 12 pollinators used in the hybridizations were primarily Rhizoctonia resistant lines developed with little regard to improvement of combining ability. The test was conducted under high nitrogen fertility and abundant moisture. Results of this test are presented in Table 3. The results of the test indicate that FC 607 has good general combining ability even with non-commercial-type pollinators. Eight of 12 hybrids were equal to the adapted commercial variety for sucrose %. All 12 of the hybrids had rapid emergence and good vigor. FC 607 has shown good mature plant vigor, and is a good seed producer under Oregon conditions. The vigor and good seed producing attributes of the line give the breeder the option of using the line in single cross hybrids. If so used, the number of genes controlling resistance to *Cercospora* and curly top that are transferred from the FC 607 parental line to the hybrid theoretically will be double that transferred as a 3-way top-cross hybrid.

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Table 3. The performance of FC 607 in hybrid combination with 12 narrow base pollinators under disease-free conditions at Ft. Collins, 1979.

Entry	Description	Root yield (T/A)	Sucrose %	Gross sucrose (lb/A)
897	FC 607 CMS X FC 703, 3rd cyc. greenhouse sel.	24.79 bc[1/]	13.70 ab[1/]	6792
898	FC 607 CMS X syn. from prog. lines of GW 674 and C 817	25.38 bc	12.87 def	6532
899	FC 607 CMS X Aula Dei 13, high sucrose (Spanish line)	26.07 b	14.30 a	7456
900	FC 607 CMS X 2nd cyc. small sel. EL-42 (East Lansing)	25.21 bc	12.51 fg	6307
901	FC 607 CMS X syn. FC 701/5	29.64 a	12.85 def	7617
902	FC 607 CMS X M-line syn. from FC 702/5	25.28 bc	13.73 ab	6941
903	FC 607 CMS X Fargo rot res. USSR line	22.47 def	12.58 fg	5653
904	FC 607 CMS X Rh. res. mm (narrow base)	29.26 a	13.07 bcdef	7648
905	FC 607 CMS X 1 cyc. Rh. sel. from F 1002	21.88 ef	12.95 cdef	5666
906	FC 607 CMS X 1861 T.O. mm	26.14 b	13.59 bc	7104
907	FC 607 CMS X 741026h, high suc. and LSR, MM (from Ft. Collins)	24.58 bc	12.75 ef	6267

--Contd.--

Table 3. The performance of FC 607 in hybrid . . . . . .(Contd.)

Entry	Description	Root yield (T/A)	Sucrose %	Gross sucrose (lb/A)
908	FC 607 CMS X 741026H2, high suc. and LSR, MM (from Ft. Collins)	23.49 cd	12.66 f	5947
909	GW Mono Hy D2	31.24 a	13.46 bcd	8409
910	FC 607 CMS (Breeder's seed)	24.51 bcd	13.35 bcde	6544
911	FC 606 (as released)	23.46 cde	12.48 fg	5855
912	FC 606 T.O. (as released)	21.33 f	12.00 g	5119
	C. V. %	5.11	4.39	

1/ Means within a column followed by the same letter are not significantly different at the 5% level.

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Planting Date X Cercospora Interaction Study.--G. A. Smith and E. G. Ruppel

Our experience with cercospora leaf spot has shown that the younger leaves of sugarbeet plants appear to be more resistant to *Cercospora* infection than older leaves. This observation is even noted on highly susceptible genotypes. We reasoned that perhaps plant age at time of inoculation might have an effect on the subsequent disease severity. Therefore, we designed a field study in 1979 to determine the effect of planting date on leaf spot severity, and to further determine if genotypes with different degrees of inherent leaf spot resistance react relatively the same when planted on different dates. The inoculation date was the same (July 9) for each planting date. Three breeding lines with distinctly different levels of resistance to *Cercospora* were planted April 2, April 18, and May 4. The experimental design was a randomized complete block with six replications. Plots were 2 rows, 21 feet long.

The average leaf spot ratings for the three lines evaluated are presented in Table 1. Results presented are from the September 4 leaf spot rating which was the peak of the epidemic.

Table 1. The average leaf spot rating of three breeding lines, each planted on 3 calendar dates.

Entry	Description of Line	Planting date Apr. 2	Apr. 18	May 4
1340	FC (504 X 502/2)X SP6322-0,LSR 1/	3.3	3.3	3.2
1341	SP 5822-0, ILSR	3.7	3.7	3.6
1342	F. C. Synthetic check, LSS	6.8	6.8	6.8

1/ LSR = Leaf spot resistant; ILSR = Intermediate leaf spot resistance; LSS = Leaf spot susceptible.

Results showed no significant difference in leaf spot ratings among plants which had been planted at the three dates. Average readings based on 6 replications were nearly identical regardless of plant age. There were no visual differences in top size of plants planted April 2 and April 18, but the May 4 planting did have less top growth than the other planting dates, as expected. We concluded that plant age has little or no effect on leaf spot severity for plants that are at least 66 days old at time of inoculation. The degree of inherent leaf spot resistance had no effect on the observed pattern.

The Effect of Sterile and Normal Cytoplasm on Resistance to Cercospora.--
G. A. Smith and E. G. Ruppel

The potential differences between normal and sterile cytoplasm as indicated by reaction to *Cercospora* infection was evaluated under the severe 1979 epidemic. Reciprocal crosses were made between two red hypocotyl multigerm pollinators, and six type 0 monogerm lines and their CMS equivalents. Crosses were made between the multigerm as the male (♂) pollen parent and the CMS type 0 of each monogerm line. Hybrids between the type 0 monogerm and the multigerm pollen fertile lines were identified by hypocotyl color. Results of the leaf spot readings for two reading dates and the description of the crosses are presented in Table 1. At both leafspot reading dates, 3 single

Table 1. Leaf spot evaluation of single crosses with and without sterile cytoplasm.

Entry	Description	Leaf spot reading[1] 8/28	9/4
1245	52-305,rr, TO X[FC(504 X 502/2)CMS X SP6322-0,R-]	3.7	4.5
1246	52-305 CMS, rr X[" " " "]	4.5	4.9
1247	FC 504,rr, TO X [" " " " R-]	2.5	3.2
1248	FC 504 CMS,rr X [" " " "]	3.8	4.3
1249	NB1, rr, TO X [" " " " R-]	3.5	4.0
1250	NB1 CMS, rr X [" " " "]	4.4	5.0
1251	52-305, rr, TO X FC 901, R-	5.5	6.0
1252	52-305 CMS, rr X " " "	4.9	5.1
1253	FC 504, rr, TO X " " "	4.1	4.4
1254	FC 504, CMS,rr X " " "	4.3	4.3
1255	FC 603, rr, TO X " " "	4.3	4.9
1256	FC 603 CMS, rr X " " "	4.4	4.8
1257	671201H03, LSR check	3.9	4.8
1258	731083, LSS check	6.8	6.6
1259	A 63-5, ILSR check	4.0	3.8

[1] Leaf spot readings based on 0-10 scale with0 being no leaf spot and 10 = complete defoliation.

cross pairs (entries 1245-1250) showed significantly more leaf spot in hybrids synthesized with the CMS parents. These six hybrids all had the same multigerm pollinator. One hybrid with FC 901 as the pollinator had significantly less leaf spot when the female parent was CMS.

There were no other significant differences between CMS and type O hybrids for leaf spot reaction when FC 901 was the pollinator. Results of this test might suggest that differences in reaction to *Cercospora* between normal and sterile cytoplasm is pollinator specific. However, more pollinator lines would need to be evaluated to make such conclusions.

BEET SEED PRODUCTION IN THE GREENHOUSE UNDER SODIUM-VAPOR AND INCANDESCENT LIGHT

R. J. Hecker and G. A. Smith

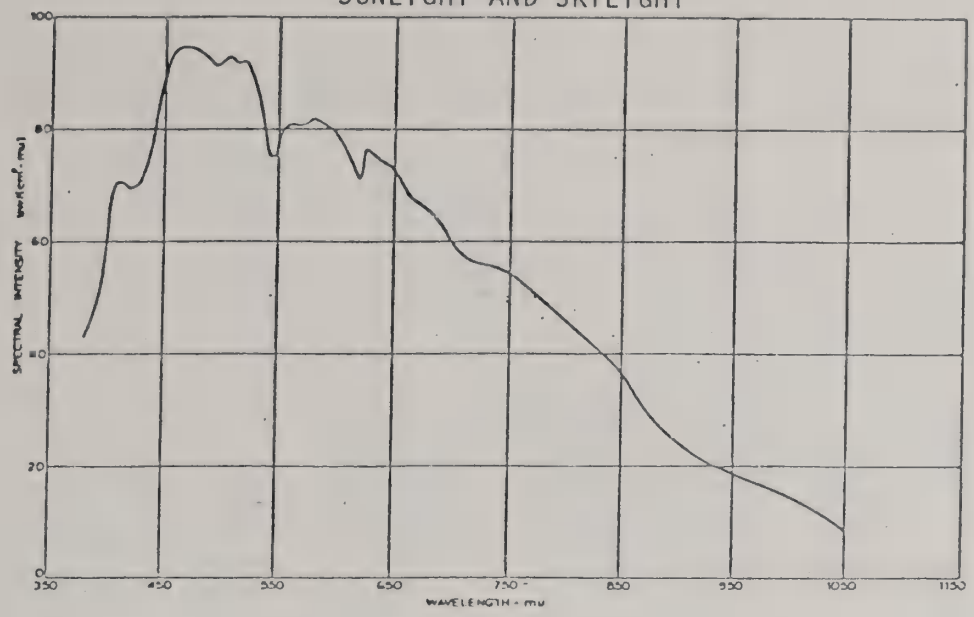
Sugarbeet seed produced in the greenhouse, particularly during winter, is commonly low in quantity and quality. In an attempt to improve greenhouse seed production, we have compared supplemental high pressure sodium vapor light with incandescent light.

The visible portion of radiant energy is between 380 and 760 mμ. Energy utilized in photosynthesis is essentially in the range of 400-700 mμ; hence, photosynthesis takes place entirely within the visible portion of the spectrum. The vast majority of solar radiant energy is in the visible spectrum, whereas the majority of radiation from tungsten incandescent light is in the infrared and far-red portions of the spectrum, far beyond the range of utilization in photosynthesis as indicated in the figures below. The figures also show that almost all the radiant energy from high pressure sodium vapor light falls within the visible and photosynthetic portion of the spectrum. Hence, sodium vapor light produces more radiant energy in the photosynthesis range than incandescent light, per watt of input. The quality of sodium vapor light is different, however, since high quantities of light are produced at very specific wavelengths.

In this experiment, we used our standard 6 X 6 X 6-ft filtered-air greenhouse isolation chambers, placing 26 steckling roots of a normal bolting, genetically broad-base multigerm population in 6-inch plastic pots. The induced stecklings were potted January 15, 1979, and immediately placed in their respective isolators under a 150-watt incandescent lamp in an ordinary porcelain reflector and under a 150-watt high pressure sodium vapor lamp (General Electric Lucalux low-mount fixture with a high pressure sodium vapor bulb). The lights operated from 4:00 p.m. to 8:00 a.m. During the day, the experiment received solar light through the glass greenhouse and plastic film of the isolators.

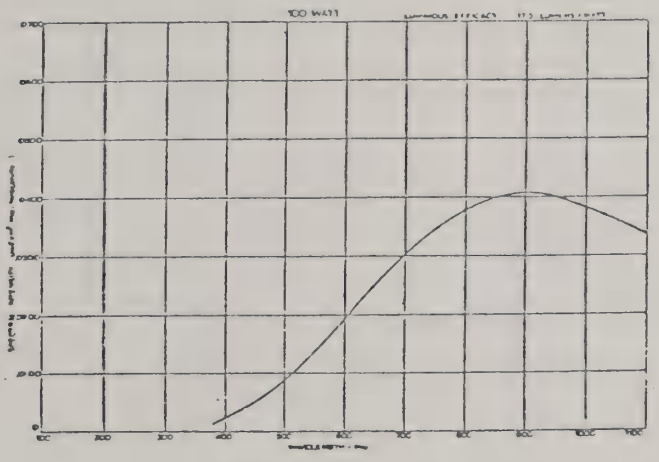
Each plant was numbered, supported by a cane, and rearranged within the treatment on a regular basis. Seed was harvested separately from each plant.

SUNLIGHT AND SKYLIGHT

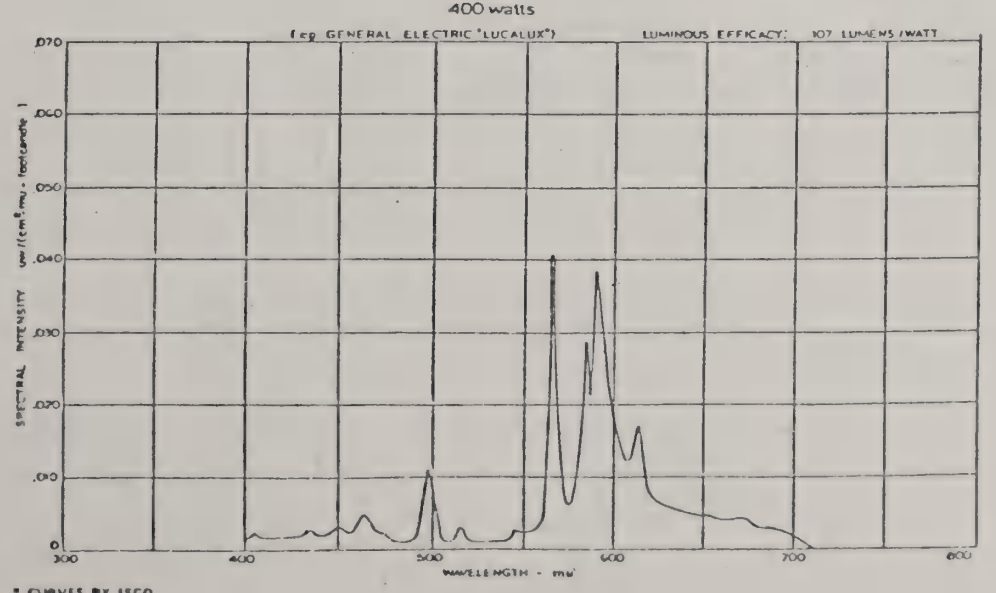


* CURVE PRODUCED BY ISCO MODEL SR SPECTRORADIOMETER AND SRR PROGRAMMED SCANNING RECORDER ON FEB. 21, 1968 AT 11:30 A. M., 40° 48' N LATITUDE AND 96° 42' W LONGITUDE.

* 100 WATT TUNGSTEN INCANDESCENT LAMP



HIGH PRESSURE SODIUM VAPOR LAMP



* CURVES BY ISCO

All measurements were made on individual plants and lots. All plants in each treatment bolted. Six and three plants died under the incandescent and sodium vapor light, respectively.

The results in Table 1 are a mean of individual plant measurements. Plants which received supplementary sodium vapor light bolted and flowered significantly sooner and were harvested 9 days earlier than those which received incandescent light. The former plants also produced more seed of significantly better germination.

It appears that sodium vapor lamps should be advantageous for greenhouse seed production, particularly because of the apparent increase in seed quantity and quality, as well as the reduction of time from planting to harvest. A succeeding experiment is now in progress in which we will be comparing these light sources on photothermally induced seedlings of normal and bolting resistant genotypes.

Table 1. Mean of seed production characteristics of 26 plants under sodium vapor and incandescent post-induction light.

	Sodium vapor	Incandescent	Probability of sig. diff.
Days to bolting	26.1	27.7	.05
Days to 1st flower	48.0	53.9	.005
Days to harvest	98.3	107.3	.0001
Stalk ht. at 1st flower (cm)	109	113	.37
Seed yield/plant (g)	12.5	7.4	.004
100 seed wt. (g)	1.73	1.54	.12
% germination			
7 days	113	92	.06
9 days	131	102	.05
14 days	140	108	.001

SUGARBEET RESEARCH

1979 Report

Section D

North Dakota Agricultural Experiment Station, Fargo, North Dakota

Dr. W. M. Bugbee, Plant Pathologist
Dr. D. F. Cole, Plant Physiologist
Dr. Larry Campbell, Geneticist

Cooperation:

American Crystal Sugar Company
Minn-Dak Sugar Cooperative
Minnesota Agricultural Experiment Station
North Dakota Agricultural Experiment Station
Sugarbeet Research and Education Board of
Minnesota and North Dakota

The research was supported in part by funds provided through the Sugarbeet Research and Education Board of Minnesota and North Dakota.

CONTENTS

SUGARBEET DISEASE RESEARCH - 1979

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Bacterial leafspot

The cause of bacterial leafspot on sugarbeets in the Red River Valley is Psuedomonas syringae. This bacterium was isolated from infected leaves, purified, and reinoculated back to sugarbeet leaves in the field and greenhouse. Inoculation was accomplished by high pressure spraying a stream of the bacteria suspended in water onto the leaves. The pressure was great enough to force bacteria into the leaves through the stomata. This method of inoculation will be used to evaluate the resistance to this bacterium in the commercial varieties that are available to growers. This disease has been with us for several years and has not caused yield losses. The objective of this test then is simply to gain information as to the relative susceptibility of these varieties under controlled experimental conditions in the greenhouse and field.

Evaluating storage rot resistance caused by mold

Mold fungi comprise species within the genera of Penicillium, Aspergillus, and Rhizopus. Sugarbeets suffer storage rot caused by several mold fungi within the genus Penicillum. We have been evaluating roots for resistance to P. claviforme for several years. A second mold fungus, P. funiculosum also rots stored sugarbeets and has been prevalent in commercial piles. Penicillium claviforme is antagonistic towards Botrytis cinerea, an important storage rot fungus, so the two can not be used as mixed inoculum in evaluation tests. Tests were performed to see if P. claviforme could be mixed with P. funiculosum so that resistance to both fungi could be evaluated simultaneously. The results were favorable. They showed that freshly harvested roots were more susceptible to P. funiculosum than P. claviforme. As roots aged in storage they became susceptible to P. claviforme. It is suggested that future storage rot evaluations consist of mixed inoculum of P. claviforme plus P. funiculosum, in addition to the separate evaluations against Phoma betae and B. cinerea.

Phoma seedling disease and storage rot

Sugarbeet seed of cultivar US H20 heavily (95%) or moderately (25%) infected with P. betae were treated with recommended amounts of sodium p-(dimethylamino) benzenediazo-sulfonate (diazoben, Dexon), a mixture of pentachloronitrobenzene and 5-ethoxy-3-(trichloromethyl)-1, 2, 4-thiadiazole (PCNB-ETMT, Terra-Coat L-205), 1-(N-propyl-N-(2-(2, 4, 6-trichlorophenoxyl) ethyl)carbamoyl)imidazole (imidazole) or bis (dimethylthiocarbamoyl) disulfide (thiram). Thiram also was applied by soaking seed in a 0.2% aqueous suspension for 24 h at 30 C. Thiram and thiram-soak treatments were applied in 1977. The other three treatments were added in 1978. Stand counts for any of the seed treatment were not

improved over untreated seed under field conditions in 1977 (table 1) and 1978 (table 2). However thiram-soak in 1977 and all treatments in 1978

Table 1. Stand counts and amount of seedling infection by Phoma betae after treatment of sugarbeet seed of US H20 in 1977. About 95% of the seed was naturally infected with P. betae.

seed treatment	stand/30 row ft	percent of Phoma infected seedlings
	no.	%
thiram soak [a/]	36 a	16 b
thiram, 224 g/45 kg	38 a	41 a
water soak	38 a	36 a
no treatment	40 a	49 a

a/ Seed were soaked 24 h in 0.2% thiram aqueous suspension, or water at 30 C. Means of 8 replications; means within a column followed by a common letter are not significantly (P = 0.05) different according to Duncan's multiple range test.

Table 2. The effect of seed treatments on seedling disease, storage rot, and recoverable white sugar per ton (RWST) of roots of cultivar US H20 with seed naturally infected with Phoma betae at two levels.

percent of Phoma infected seed	seed treatment	stand count 10 row ft.	percent of Phoma infected seedlings	percent rot (w/w)	RWST harvest	RWST stored
		no.	%	%	lbs	lbs
95%	none	15 a	44 a	14.0 a	204 a	122 ab
	diazoben	14 a	27 b	9.8 bc	197 a	136 a
	PCNB-ETMT	14 a	23 bc	9.5 bc	196 a	118 b
	thiram	14 a	13 cde	9.8 bc	199 a	130 ab
	thiram soak	13 a	7 efg	9.6 bc	196 a	132 ab
	imidazole	13 a	4 fg	6.4 c	198 a	136 a
25%	none	18 a	28 b	12.2 ab	200 a	124 ab
	diazoben	17 a	20 bcd	12.6 ab	196 a	127 ab
	PCNB-ETMT	19 a	16 cde	9.6 bc	198 a	128 ab
	thiram	17 a	11 defg	9.6 bc	197 a	135 a
	thiram soak	18 a	5 efg	8.2 bc	198 a	131 ab
	imidazole	19 a	2 g	10.1 bc	199 a	124 ab

Means of 16 replications; means within a column followed by a common letter are not significantly (P = 0.05) different according to Duncan's multiple range test.

caused a reduction of Phoma infection in surviving seedlings. The most effective treatments were thiram, thiram-soak, and imidazole. All seed

treatments in 1978 resulted in less rot in roots that were stored for 150 days at 4-6 C compared to storage rot in roots from untreated seed. The amount of storage rot was positively correlated with the number of surviving seedlings infected with P. betae. The regression showed that a 0.4% increase in storage rot occurred for each 10% increase in infected seedlings. The correlation was significant (P = 0.05) but low (r = .15) indicating that sources of P. betae inoculum other than the seed was contributing toward infection and rot, therefore, seed treatments to reduce infection by P. betae would result only in partial reduction of storage rot. The reduced rot was not enough to cause a reduction in the loss of RWST (table 2). A regression analysis showed a negative effect of percent storage rot on recoverable white sugar per ton. The regression was linear for 0-15% rot and showed a 6 lb/T sucrose loss after 150 days storage for each 1% increase in storage rot. A mid-range rot of 20% caused a loss of 100 lbs/T under ideal storage conditions for 150 days at 5 C. Most of the rot probably was due to P. betae because the treatment of roots with 2-(4-thiazolyl) benzimidazole (thiabendazole) was ineffective. Thiabendazole reduces rot caused by common storage pathogens except roots deeply infected with P. betae.

Identifying Phoma storage rot resistance in the seedling stage

Last year I reported that two breeding lines developed for resistance to phoma storage rot also were resistant to Phoma in the seedling stage. This conclusion was based on greenhouse tests where temperatures fluctuated, sometimes going over 90° F. When these tests were repeated at lower controlled temperatures in newly acquired growth chambers, seedlings of resistant lines suffered an unexpected increase of seedling disease. Further testing showed that seedling disease caused by Phoma increased as the temperature decreased. This was expressed as a lower stand count and an increase in the amount of emerged seedlings that were infected with Phoma. Therefore, at 60° F, differences between the storage rot resistant line and the susceptible cultivar lines could not be detected.

A test was begun to improve the performance of the two breeding lines at 60°. Several hundred seed of each line were inoculated with Phoma and planted in soil at 60°. One month later, the surviving seedlings were examined for seedling disease and the apparently healthy seedlings were transplanted. Seed will be produced from these selections to see if seedling performance and subsequent storage rot resistance has been improved. Perhaps storage rot resistance can not be detected using the seedling reaction to Phoma, but it is highly probable that seedling resistance to this fungus can be improved by selection at 60°.

SUGARBEET STORAGE - 1979

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North Dakota Agricultural Experiment Station
Fargo, North Dakota

Internal CO_2 vs. Respiration

Internal CO_2 can be determined on individual roots (genotypes) in less than 2 minutes. Measurement of respiration is usually accomplished in an open system using an infrared gas analyzer. Several problems can affect the operation of the system: regulation of air flow, control of background CO_2 levels, calibration, and the number of samples that can be efficiently handled. Automated systems have been developed, but only a limited number of samples can be measured during a day.

The objectives were to examine the relationship between internal CO_2 and respiration rate (evolved CO_2) in sugarbeets and if internal CO_2 levels could be altered by selection.

Two sugarbeet cultivars ('ACH-17' and 'GW Mono-Hy D2') were grown at Fargo, N.D., on a fine-textured clay soil. The seed were planted on May 10 and the roots were harvested on October 10, 1979. The experimental design was a randomized complete block with 9 replications. Plots were 4-rows wide and 7.6 m long. The plots were defoliated before harvest with a commercial rotobeater. Roots from the two center rows of each plot were harvested with a two-row lifter to raise the roots to the soil surface. The roots were picked up manually, washed and stored in perforated plastic bags at 5 C and near 100% relative humidity.

After 25 days of storage at 5 C, a subsample of 3 roots from each plot was transferred to 10 C and another subsample of 3 roots to 15 C. After an additional 5 days of storage, respiration rates were measured on individual roots for both cultivars at 5, 10 and 15 C. Respiration rates were measured with a differential infrared gas analyzer in an open system with outside air.

Immediately after respiration rates were measured, a core (1 cm x 6 cm) was removed from each root and the cavity was sealed with a serum vial stopper. Internal CO_2 levels were determined by removing a gas sample (1.0 ml) from the sealed cavity with a needle and syringe 24-36 hrs. after sealing. CO_2 was measured on a gas chromatograph fitted with a silica gel column by injecting 0.5 ml of the air removed from the sealed cavity. The procedure was repeated on another sub-sample of roots 55 days after harvest.

Seed of 4 commercial cultivars (ACH-17, GS-Mono-Hy D2, 'Beta 1934', 'Bush Mono'), seed from 4 cycles of selection for low internal CO_2 concentration, and seed from 2 cycles of selection for high internal CO_2 concentration were planted on a fine textured clay soil at Fargo, N.D., on May 10 and harvested on October 10, 1978.

The field design was a randomized complete block with two replications. Rows 1 and 4 of each plot (rows 56 cm apart and 10.5 m long) were seeded with a common commercial cultivar because the supply of seed for some of the high and low internal CO_2 populations was limited.

The roots were harvested and stored as previously described. Internal CO_2 concentrations were determined for up to 16 roots per replicate as previously described after 80 days of storage at 5 C.

Cultivars differed significantly for both internal CO_2 and respiration rates when averaged over all temperatures. The cultivar by temperature interaction was not significant, therefore, both cultivars responded similarly to changes in storage temperatures (Fig. 1). The correlation coef-

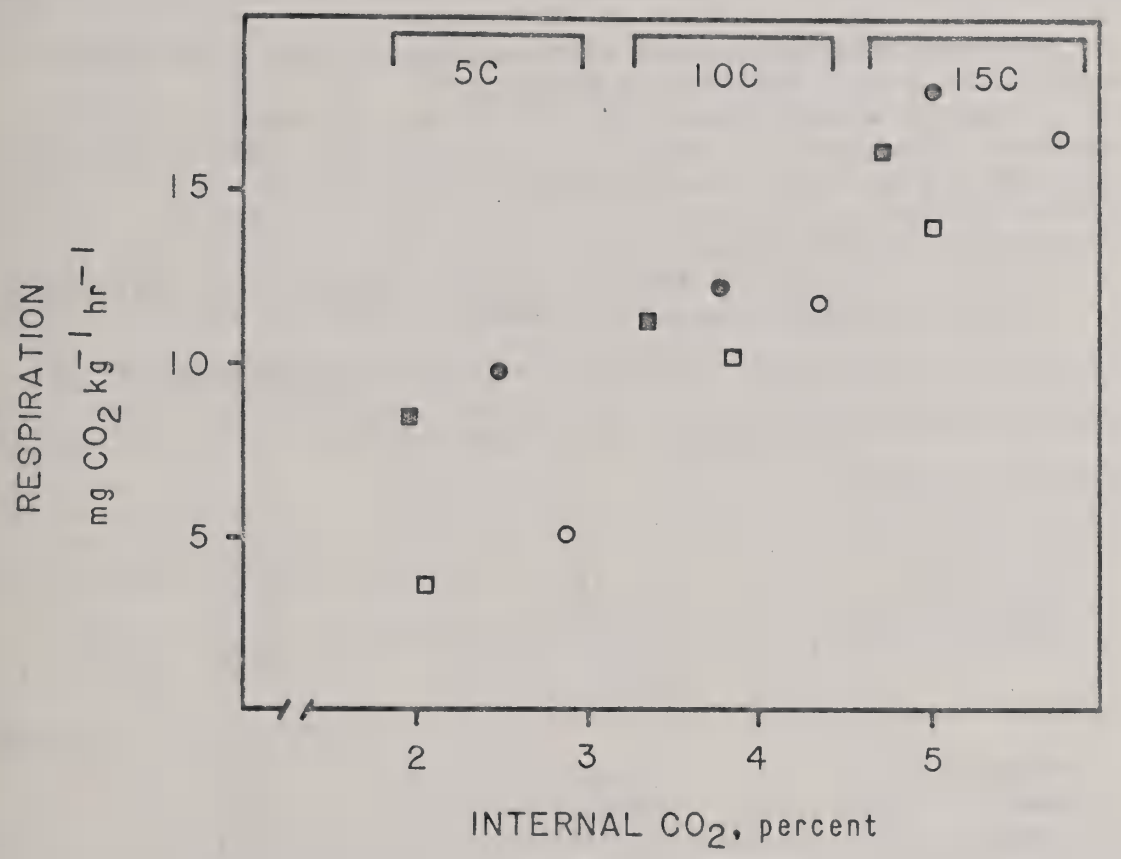

Figure 1. Relationship between internal CO_2 and respiration rate as influenced by storage time.

■ GW Mono-Hy D2 30 days after harvest ● ACH-17 30 days after harvest
□ GW Mono-Hy D2 60 days after harvest ○ ACH-17 60 days after harvest

ficients between respiration and internal CO_2 of individual roots (n = 162) at 30 and 60 days after harvest were r = 0.72** and r = 0.85**, respectively. The correlation coefficients were r = 0.98** and r = 0.99**

at 30 and 60 days after harvest, respectively, when the correlations were based on the cultivar x temperature means (n = 6, Fig. 1). These data indicate that the level of CO_2 inside the root is related to the respiration rate. Therefore, selection on an individual root basis for low respiring genotypes is possible by measuring the internal CO_2 level. Internal CO_2 is simple to measure and remains constant for a 7-day period.

Significant differences among the four cultivars were detected for internal CO_2 (Table 1). Cultivar Beta 1934 was significantly lower than the other three cultivars. The orignal populations with low and high internal CO_2 levels were selected because they were among the lines with the lowest and highest CO_2 levels described by Cole and Bugbee. Roots evaluated from cycles 2, 3 and 4 of the low CO_2 line had a lower CO_2 concentration than the original population, and had significantly lower CO_2 levels than did all of the commercial cultivars evaluated in this test.

The roots evaluated from cycle 1 of the high CO_2 line had internal CO_2 levels significantly higher than those of the original population (Table 1). Roots of cycle 2 had significantly higher internal CO_2 levels than did roots of cycle 1. Internal CO_2 levels in both cycle 1 and cycle 2 were higher than those of all the commercial cultivars.

Table 1. Number of roots evaluated and internal CO_2 levels of four commercial cultivars and populations derived through selection for low and high internal CO_2 levels.

	n	Internal CO_2 %
Commercial cultivar		
Bush Mono	29	2.79
Beta 1934	31	2.55
GW Mono-Hy D2	18	2.82
ACH-17	22	2.92
Low lines		
Original	24	2.42
Cycle 1	22	2.56
Cycle 2	14	2.20
Cycle 3	19	2.14
Cycle 4	27	2.07
High lines		
Original	26	2.66
Cycle 1	25	3.26
Cycle 2	30	3.55

$$LSD_{0.05} = 1.96 \sqrt{\frac{1}{ni} + \frac{1}{ns}\,(0.2061)}$$

The data reported herein indicate that respiration and internal CO_2 are related and that internal CO_2 levels can be altered by selection. Measurement of internal CO_2 is easy to accomplish and over 200 roots per day can be evaluated for internal CO_2 levels.

Raffinose Determinations

Mr. John Hobbis, American Crystal Sugar Co., advised me that a commercial instrument designed to measure sucrose, glucose and lactose using immobilized enzymes in a polycarbonate membrane was available. Lactose measurement is accomplished with galactose oxidase. The enzyme is also sensitive to galactose, raffinose, melibiose and stachyose.

The membrane containing the enzyme is mounted on a silver and platinum electrode in a reaction chamber. A 25 µl sample is injected into the reaction chamber. The sample is mixed in the reaction chamber with a buffer by a silicone rubber diaphragm driven by an oscillating stream of air.

Raffinose accumulates in sugarbeets during storage and causes errors in the polarimetric determination of sucrose in cold digestion or thin juice filtrates. Therefore, it is necessary to determine raffinose in the extracts. The instrument was used in our laboratory to measure raffinose in cold digestion extracts clarified with aluminum sulfate and in thin juice samples (Dexter et al, JASSBT 14:433-454). A sample of each filtrate was injected into the instrument without additional preparation.

The major problem encountered was that a large number of the membranes were defective when received through the normal supply channels. The manufacturer is working to correct the large failure rate.

The instrument was used in our laboratory to measure raffinose in over 4 thousand samples at a rate of 200 per day. One thousand samples have been evaluated with one membrane.

The instrument is a Model 27 Industrial Analyzer developed by Yellow Spring Instrument Co., Yellow Spring, Ohio.

Comparison of 9 Cultivars

A study was conducted in 1979 to compare yield, quality at harvest, quality after storage and the amount of crown vascular and crown parenchyma (pith) tissue of nine cultivars developed by American Crystal Sugar Company over the last three decades.

Seed was obtained from Dr. John Kern, American Crystal Sugar Company, Moorhead, Minnesota. The seed was planted at Fargo on May 25 on a fine-textured clay soil and the roots were harvested on October 18. The experimental design was a randomized complete block with 8 replications. Plots were 4-rows wide and 7.6 m long. Leaves were removed with a commercial rotobeater prior to harvest. The roots were raised to the soil surface with a 2-row lifter and picked up manually. A subsample of 10 consecutive beets in one row was obtained. The remaining roots were pooled with the root from the other row.

The sample of 10 roots was washed, weighed and separated into root, crown vascular and crown parenchyma tissues. Each component was weighed and subsampled to measure sucrose and other quality components, i.e., sodium, potassium and amino-N.

The larger sample of roots was washed, weighed, and divided into two lots. One lot was used to measure quality at harvest and the other lot was stored in perforated plastic bags at 5 C and near 100% relative humidity for 110 days. Sucrose was determined by the cold digestion procedure using aluminum sulfate as the clarifying agent. Purity was determined by the procedured described by Dexter et al.

The cultivars grown in the 1970's had a higher yield, purity and recoverable sugar per acre than older cultivars (Table 2). Cultivar ACH-14 had a higher recoverable sugar per ton than the other cultivars. Sugar content of the individual tissue differed among cultivars, however, there was no trend for the newer cultivars to be higher than the older cultivars. Significant differences in the amount of crown parenchyma and crown vascular tissue were observed. Cultivars 3S and ACH-30 had the largest and smallest amount of crown tissue, respectively.

A correlation coefficient of $r = 0.96$ ($n = 9$) was observed between the sugar content of the crown vascular tissue and the sugar content of the main tap root based on cultivar means.

The data on sodium, potassium, amino-N and quality after storage are not yet available.

Table 2. Yield and various quality components of 9 cultivars.

Cultivar	Decade used	Yield T/A	Sugar, %			
			Pith	Crown	Root	Intact
ACH-30	1970	21.0 ab	10.2 ab	13.8 bc	16.8 b	15.9 b
ACH-12	1970	21.6 a	10.3 ab	13.2 c	16.0 b	15.5 bc
ACH-14	1970	19.4 bc	11.4 a	15.0 a	17.9 a	16.8 a
ACH-17	1970	21.9 a	9.2 bc	13.2 c	16.1 b	15.3 c
3N	1960	20.3 ab	8.5 c	13.8 bc	16.7 b	15.4 bc
3S	1960	19.4 bc	10.1 ab	13.3 c	15.9 b	15.6 bc
51-807	1950	17.9 c	10.2 ab	13.9 bc	16.5 b	15.5 bc
51-410	1950	14.2 d	9.5 bc	13.4 c	16.0 b	15.6 bc
47-801	1950	19.5 bc	10.3 ab	14.2 b	16.7 b	15.6 bc

Cultivar	Purity %	RWST lbs	RWSA lbs	Tissue above lowest leaf scar (% of total root)		
				Parenchyma	Vascular	Total
ACH-30	92.2 ab	268 b	5634 a	1.6 c	15.9 c	17.4 b
ACH-12	92.1 ab	262 b	5664 a	2.0 b	17.2 bc	19.2 ab
ACH-14	93.4 a	291 a	5659 a	2.2 ab	18.7 ab	20.9 a
ACH-17	91.9 ab	257 b	5636 a	2.5 a	18.1 abc	20.5 a
3N	91.6 ab	257 b	5202 ab	2.1 ab	17.4 bc	19.5 ab
3S	90.2 b	249 b	4869 b	2.0 b	19.5 a	21.5 a
51-807	91.5 ab	258 b	4622 b	1.9 bc	17.7 abc	19.5 ab
51-410	91.1 b	255 b	3630 c	1.6 c	16.5 c	18.1 b
47-801	91.3 ab	257 b	5013 ab	2.1 ab	17.2 bc	19.3 ab

SELECTING FOR IMPROVED SUGARBEET STORABILITY

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In areas such as the Red River Valley, where sugarbeets are stored for long periods, a considerable amount of sugar can be lost during storage. This loss results primarily from respiration and secondarily from storage rots. The growth of storage rot fungi on small sugarbeet slices was used to identify beets resistant to one or more of the pathogens. Respiration rate in storage was determined by measuring the percent CO_2 (carbon dioxide) in a stoppered cavity made with a cork bore.

In 1978 individual beets from lines in the world collection were examined for internal CO_2 concentration and response to the storage rot fungi Phoma betae, Botrytis cinerea and Penicillium claviforme. A few lines that appeared to be superior were increased by crossing superior plants within the line (Table 1). Selection for Phoma resistance appeared to be the most effective with the mean of selected lines significantly better than the check. While selctions for Botrytis and Penicillium resistance had lower rot ratings than the check, the differences were small. Many lines selected for Botrytis and Penicillium in 1978 also had Phoma resistance which was manifest again in the 1979 data. Selection for low respiration resulted in only a minor but probably significant difference between selected material and the check. The response of crosses between selected plants and GW-D2 (CMS) was similar to that observed for individual lines.

A number of roots were selected for each trait on the basis of their individual performance. These were included in a separate polycross for each trait. Seed was harvested from individual plants for 1979 field and storage evaluations. Three CMS lines (GS-D2, 1861, 52-307) were also included in the polycross. The 44 beets selected for low respiration had a mean internal CO_2 concentration of 1.19% compared to an overall mean of 2.03%. In 1979 storage trials the polycross progeny of these beets averaged 2.06% compared to an average of 2.42% for the check cultivar (ACH-14). Individual lines (half-sib families) ranged from 1.48% (PI174058) to 2.40% (PI176872). Fifteen beets were selected for resistance to Phoma in 1978. Polycross progeny of these individuals had a Phoma rating of 3.6 compared to 4.6 (0 = no rot, 5 = severe rot) for the ACH-14 check. In 1978, 30 beets were selected for resistance to Penicillium. Progeny of these plants had a Penicillium rating of 1.9 compared to 3.0 for ACH-14. Progeny of lines selected for resistance to Botrytis in 1978 appeared to be highly susceptible in 1979.

Twelve beets were selected for resistance to all three fungi in 1978. The 1979 data indicated that selection for resistance to all three organsisms was somewhat effective. While selection for Botrytis resistance was not as effective as was selection for the other fungi, the results were more favorable than when selection was for Botrytis alone. A large majority of the beets selected for combined rot resistance were red; whereas, selection of white sugar types was possible for the individual

Table 1. Characterization of lines selected from the world collection of sugar-beets for resistance to storage rot fungi and reduced respiration during storage.

Designation	Phoma	Botrytis	Penicillum	Respiration rate
	- - - - -	rating[+]	- - - - - - -	- - % CO_2 - -
Phoma selections				
PI120691	2.5	4.8	4.5	---
PI120282	3.2	5.0	5.0	---
PI251042	4.0	5.0	5.0	---
PI120704	2.1	3.5	4.4	---
PI205987	3.1	4.6	4.7	---
Mean of selections (1979)	3.0	4.6	4.7	---
Mean of parents (1978)	0.7	4.9	4.1	---
GW-D2/PI120282	3.4	4.9	4.4	---
GW-D2/PI251042	3.9	4.8	4.8	---
GW-D2/PI140354	3.9	4.7	4.6	---
GW-D2/PI266101	3.6	4.7	4.9	---
GW-D2/PI120704	2.8	4.5	4.8	---
GW-D2/PI117113	3.4	4.6	4.7	---
GW-D2/PI171519	2.1	3.8	4.9	---
GW-D2/PI205987	2.7	4.8	4.6	---
GW-D2/PI117117	4.0	5.0	5.0	---
Mean	3.3	4.6	4.7	---
Botrytis selections				
PI175599	3.3	3.5	4.6	---
PI180409	3.9	4.6	4.5	---
PI178836	3.5	4.6	4.7	---
Mean of selections (1979)	3.6	4.2	4.6	---
Mean of parents (1978)	3.1	1.4	3.5	---
GW-D2/PI175599	3.5	4.5	4.8	---
GW-D2/PI180409	3.9	4.6	3.2	---
GW-D2/PI120692	3.0	4.9	4.6	---
GW-D2/PI169021	2.3	4.3	4.5	---
Mean	3.2	4.6	4.3	---
Penicillium selections				
PI178837	1.9	3.8	4.5	---
PI176427	4.2	4.9	5.0	---
Mean of selections (1979)	3.0	4.4	4.2	---
Mean of parents (1978)	3.8	4.8	1.9	---
GW-D2/PI176427	3.7	4.8	4.6	---
GW-D2/PI142816	4.1	4.9	3.3	---
GW-D2/PI164978	3.0	4.7	4.6	---
GW-D2/PI176872	3.8	5.0	5.0	---
Mean	3.6	4.8	4.4	---

Table 1. Continued

Designation	Phoma	Botrytis	Penicillium	Respiration rate
	-----	rating†	----------	-- % CO_2 --
Low respiration selections				
PI171507(a)	---	---	---	1.55
PI171507(b)	---	---	---	1.62
PI173842	---	---	---	1.95
Mean of selections (1979)	---	---	---	1.71
Mean of parents (1978)	3.4	4.8	4.4	1.17
GW-D2/PI171507	---	---	---	1.53
GW-D2/PI117113	---	---	---	2.17
GW-D2/PI173842	---	---	---	1.72
GW-D2/PI140351	---	---	---	1.74
GW-D2/PI181716	---	---	---	1.66
Mean	---	---	---	1.76
ACH-30	4.8	5.0	5.0	1.92

† Rot rating indicates the distance rot progressed through a 1 cm^2 block of root tissue after incubation at 20 C for 2 weeks. 0 = 0 mm; 1 = not over 2 mm; 2 = 2-4 mm; 3 = 4-6 mm; 4 = 6-8 mm; 5 = 8-10 mm (entire block).

traits. Superior individuals from promising lines are being increased to confirm their low respiration rate or rot resistance and to evaluate for other important traits.

A number of individuals from crosses between 52-307CMS and low respiration selections appeared to have relatively low respiration rates. Respiration rates in crosses with GW-D2 and 1861 were relatively high. The 52-307 crosses with Phoma resistant selections also produced a relatively high frequency of individuals resistant to Phoma. Penicillium resistant selections were made from crosses between Penicillium resistant selections and all three male steriles; however, means for the 52-307CMS and 1861CMS crosses were considerably lower than those with GS-D2 as a parent.

Papers Published or Approved for Publication

Bugbee, W. M. 1979. The effect of plant age, storage moisture, and genotype on storage rot evaluation of sugarbeet. Phytopathology 69:414-416

Bugbee, W. M. 1979. Resistance to sugarbeet storage rot pathogens. Phytopathology 69:1250-1252.

Bugbee, W. M. 1979. Sugarbeet storage. Proceedings All-Congress Symposium - Sugarbeet. IX Int'l Congress of Plant Protection, August 1979, Wash. D.C.

Bugbee, W. M. and D. F. Cole. 1979. The effect of root dehydration on the storage performance of a sugarbeet genotype resistant to storage rot. J. Amer. Soc. Sugar Beet Technol. 20:307-314.

Bugbee, W. M. and D. F. Cole. 1979. Comparison of thiabendazole and genetic resistance for control of sugarbeet storage rot. Phytopathology 69:1230-1232.

Cole, D. F. 1979. Effect of complete crown removal on quality of sugarbeets. J. Am. Soc. Sugar Beet Technol. In press.

Schroeder, G. L., A. G. Dexter and D. F. Cole. 1980. Sugarbeet response to herbicide and plant growth regulators. WSSA Abstract p. 27-28.

Schroeder, G. L., A. G. Dexter and D. F. Cole. 1980. Herbicide spray drift on sugarbeets. WSSA Abstract p. 27.

SUGARBEET RESEARCH

1979 Report

Section E

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Farmers and Manufacturers Beet Sugar Association
Michigan Sugar Company
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The research was supported in part by funds provided through the Beet Sugar Development Foundation (Projects 20 and 26).

CONTENTS

Abstracts of Papers Published in 1979

1) Hogaboam, G. J., and C. L. Schneider. 1979. Efforts to control Rhizoctonia rot of sugarbeets through resistance breeding and Fungicide applications. Proceedings of the 20th Regional Meeting Amer. Soc. Sugar Beet Technol., pp 81-89. I.

   Results of 5 tests evaluating hybrids made with 5 different Rhizoctonia resistant pollinator lines and SP6822-0 on a common female parent are presented. Six fungicides with potential to reduce crown rot incidence were identified. The need for improved methods of fungicide application for control of crown rot is apparent.

2) Schneider, C. L., R. L. Sims, and H. S. Potter. 1979. Tests of fungicides to control Cercospora leaf spot and Rhizoctonia root rot diseases in 1977. In Fungicide and Nematicide Tests 34:56-57. Amer. Phytopathol. Soc.

   Among 25 spray treatments tested for leaf spot (C. beticola) control, all significantly reduced disease severity below that of the untreated control. Treatments with systemic fungicides showed greater efficacy than protective type fungicides. Among 26 crown-spray treatments tested for root rot (R. solani) control, the following reduced disease damage significantly below that of the untreated control: Bayleton 50 W (1.12 kg/ha), Benlate 50 W (0.84 kg), and Du-Ter 47 W (0.70 kg).

3) Ruppel, E. G., C. L. Schneider, R. J. Hecker, and G. J. Hogaboam. 1979. Creating epiphytotics on Rhizoctonia root rot and evaluating for resistance to Rhizoctonia solani in sugarbeet field plots. Plant Dis. Reptr. 63(6):518-522.

   Methods and techniques for mass inoculation of sugarbeet plots with dried grain inoculations of R. solani are described. The methodology was effective and reliable for testing the reaction of cultivars to the pathogen.

4) Schneider, C. L. 1979. The present need for black root control. Proc. 20th Reg. Meet. Amer. Soc. Sugar Beet Technol. East. U.S.A.

   Since the introduction of resistant cultivars in the Great Lakes area, black root damage has declined notably, but the disease has not been totally vanquished. Occasional severe local occurrences indicate the need for continued control efforts. Control measures recommended for use with resistant cultivars include crop rotation, control of weed hosts of Aphanomyces cochlioides, early planting, and seed treatment.

Evaluation of Sugarbeet Hybrids

G. J. Hogaboam

The evaluation program in 1979 was cooperative with the Farmers & Manufacturers Beet Sugar Association and its member companies.

The sugar and purity analyses were conducted by Paul Pfenninger, Michigan Sugar Company. The percent sucrose, percent clear juice purity, and recoverable white sugar per ton were determined according to "A rapid and practical method of determining extractable white sugar, as may be applied to the evaluation of agronomic practices and grower deliveries in the sugarbeet industry", by S. T. Dexter, M. G. Frakes, and F. W. Snyder, as published in the Journal of the American Society of Sugar Beet Technologists.

Hybrid Evaluation, B & B Farm, Saginaw, MI., 1979

6 replication, 2-row plots
23 ft. long, 28 in. rows

Seed No.	RWS/A	Tons/A	RWS/T	% Sucrose	% CJP
76682-01 x 76256-0	5757	19.93	288.8	17.56	92.98
76745-01 x "	5736	19.48	294.2	17.78	93.27
74323x1 x 7622-0	6286	21.10	297.9	17.92	93.49
76591-01 x "	5860	19.10	306.8	18.21	94.14
73514-01 x 76598-0 x "	5174	16.95	305.1	18.20	93.87
78614-01 x "	5648	18.27	309.3	18.27	94.37
74566-01 x EL36 x EL40	6441	21.23	303.5	18.11	93.89
74564-01 x " x "	5823	19.89	292.5	17.71	93.20
" x 74550-0 x "	5932	19.44	305.1	18.30	93.61
US H20	6132	20.59	297.7	17.89	93.55
74564-01 x 7042-0 x EL40	6400	20.77	307.9	18.42	93.70
EL44C3 x EL45 x 6822-0	6454	21.26	303.9	18.03	94.17
General Mean	5970	19.83	301.0	18.03	93.68
LSD 5%	566	1.72	12.3	NS	0.64
CV%	8.19	7.49	3.54	2.61	0.59

IN VITRO VEGETATIVE PROPAGATION OF SUGARBEET

Joseph W. Saunders

In an attempt to provide a greater number of technical options for sugarbeet improvement through germplasm storage, seed production and special testing, development of *in vitro* beet propagation methods was initiated in late 1978. The main features desired in a beet propagation system are:

1. Rapid scale-up time to dozens or hundreds of propagules if desired.
2. Easy, low maintenance, long-term storage of individual germplasm.
3. Applicability to all germplasm.
4. Ability to initiate propagation at all stages of plant development.

The two basic routes of *in vitro* vegetative propagation, by axillary shoot culture and by shoot regeneration, have been examined.

Shoot Culture. The use of nutrient agar medium containing a cytokinin to promote growth and branching has come into fairly recent popularity for propagating many economically important species. Hussey and Hepher (Annals of Botany 42:477-479. 1978) describe such a procedure for use with sugarbeet seedlings. We have been satisfied with a slightly different method that is used predominantly for shoot cultures initiated from axillary buds of flowering stalks. Cotyledonary nodes as well as embryos have also been used to initiate shoot cultures. For breeding purposes shoot cultures from beet selections are preferred, and this is best done at present with axillary buds from the flower stalk.

Lateral buds 5-15 mm long are surface sterilized in our lab by two 15-minute soaks in 15% chlorox-0.01% sodium laurylsulfate, followed by six washes in sterile distilled water. Buds then are put onto the surface of Linsmaier-Skoog medium with 0.25 mg/l benzyladenine (medium L-20) and kept at 21° C in a lighted growth chamber, although neither strong light nor strict temperature control is considered essential. Lateral buds from plants flowering in the greenhouse are easily decontaminated by this procedure, whereas the few attempts to decontaminate buds from flowering beets in the field have been unsuccessful.

The explanted buds enlarge several days after placement on the agar, and after three weeks generally 1-3 axillary shoots have grown out from the original vegetative bud. These are separated from the original axis and transferred onto fresh agar where another cycle of shoot growth and multiplication begins. If the original bud was reproductive, vegetative shoots may not develop.

Subsequent cycles, lasting 3-4 weeks, have shoot multiplication rates of 3-5. In most genotypes shoots are multiplied both by outgrowth of axillary buds, as well as by regeneration of new shoots on petioles. One genotype has been observed that does not regenerate shoots from petioles.

A similar type of regeneration is seen when 2-3 mm sections of petioles from shoot cultures are placed on L-20 medium. Up to 10% of the sections sprout shoots within a week. These shoots can be used to start multiplication cycles, thus increasing the actual rate of multiplication.

Shoots have been rooted either by placing them on Linsmaier-Skoog medium with 1.0 mg/l α-naphthaleneacetic acid in 125 ml Erlenmeyer flasks, or planting them in Jiffy-7 peat pots in clear plastic boxes where humidity is kept high, usually in a growth chamber at 21-24° C under continuous light. Large shoots survive the stress of rooting better than small ones, and trimming the shoot down appears to reduce chances for survival as fungi attack the cut surfaces.

Increases in the benzyladenine concentration above that used in the standard shoot culture medium (L-20) reduced shoot size while increasing shoot number and proportion of leaves regenerating shoots. Levels of benzyladenine below 0.25 mg/l led to fewer but larger shoots. In combination with 0.25 mg/l benzyladenine, ± cis-trans abscisic acid at 0.1 or 1.0 mg/l reduced shoot regeneration from leaves compared with the absence of abscisic acid, and had a somewhat diminishing effect on shoot size.

Regeneration from Petiole and Blade of Intact Plant Leaves. Because lateral buds of a vegetative plant are not easy to obtain contaminant-free, there is interest in being able to regenerate shoots from pieces of leaf blade or petiole, which are more easily decontaminated and are in abundant supply on the plant. This is easily done in quite a few other species. Our initial attempts using variations in benzyladenine level and combinations of concentrations of benzyladenine and α-naphthaleneacetic acid have produced rod-like structures, but no shoots. Under the desired system, shoots regenerated from pieces of leaf could be fed into shoot culture for multiplication. Regeneration from leaf pieces would permit fast propagation to be started from any size beet.

Cold Storage of Shoot Cultures. A shoot culture experiment involving combinations of cold exposures at 5° C in the dark with lengths of pre-cold 24° C growth indicated that cultures would survive at least 29 weeks at 5° C and grow well thereafter at 24° C. The shoots do appear to grow, though slowly, at 5° C, and present thought is that survival can be maximized by a high medium volume to shoot ratio. That is, death may be due to exhaustion of the medium.

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Although present methods do not permit shoot culture initiation with ease from beets of all stages, shoot culture does appear applicable to most if not all genotypes. If only a handful of propagules are desired, propagation from stem cuttings or crown buds is more economical, but when dozens or more propagules are needed, shoot culture can produce these faster.

RAPID FLORAL INDUCTION OF BEETS

Joseph W. Saunders

Growth chamber experiments with plants originated from seed and shoot cultures indicate that flowering can be achieved as early as six weeks after placement in a growth chamber with continuous incandescent light and a 14-10 hour 20-14° C fluorescent light-dark cycle. This followed up the finding of George Hogaboam that US H20 and FC701/5 could be brought to flower in continuous incandescent and fluorescent light in a 14-10 hour 22-14° C growth chamber.

The initial investigations of this phenomenon indicate that this is a technique that might be applicable in perhaps a majority of genetic backgrounds. As yet it is premature to discount the risk of unconsciously selecting for more frequent field bolting.

Floral Induction of Seedlings with Continuous Incandescent Light. 94% of the seedlings of FC701/5 flowered with 24 hour incandescent, most within six weeks. First signs of bolting were seen in some by the twentieth day after emergence. Twelve percent of the seedlings of an experimental line flowered under these conditions, as did 25% for EL39, 0% for EL40, and 6% for EL41. The last three are derived from the same single plant.

Even with 20 hours incandescent light, 28% of FC701/5 seedlings flowered within 38 days.

Six of ten plants of FC701/5 flowered after being moved into continuous incandescent light after five weeks post-emergence in a 14-10 hour fluourscent plus incandescent light-dark cycle at the standard temperature (20-14^{o} C).

No bolting was observed on plants kept in a 14-10 hour 20-14^{o} C incandescent plus fluorescent light-dark cycle.

Continuous Incandescent Floral Induction of Shoot Culture Propagules. Shoot culture propagules of seven of eight randomly selected genotypes were brought to flower under continuous incandescent light in the growth chamber, following rooting in peat pots which took 2-5 weeks at 24^{o} C under continuous incandescent and fluorescent light. Quickest time to flower was 26 days after placement of the freshly rooted propagule into potting mixture in the growth chamber at standard 14-10 hour, 20-14^{o} C fluorescent light-dark cycle with continuous incandescent light. There was no flowering or stem elongation in control propagules subjected to incandescent as well as fluorescent light for 14 hours as part of the standard cycle, using a genotype that flowered under continuous incandescent light.

Surprisingly, isogenic propagules did not respond in a unanimous manner to the continuous incandescent light. Where three or more propagules of a genotype were tested, some but not all flowered. These investigations have been of a preliminary nature, and no clues to the nature of the non-unanimous induction response are known.

Although most of the responding propagules were derived from flowering plant axillary buds, one was derived from seedling axillary buds, suggesting that the floral state was not carried over through the shoot cultures.

In combination with the rapid propagation of plants of selected genotypes by shoot culture, this method of rapid floral induction permits rapid seed increases, although of modest magnitude at present, with responsive genotypes.

SUGARBEET DISEASE INVESTIGATIONS IN 1979

C. L. Schneider

1. Fungicide Screening Tests

C. L. Schneider, R. L. Sims and H. S. Potter

a) Rhizoctonia crown rot - Spray treatments were applied in a 20-cm band along the plant rows and into the crowns at the rate 560 liters of spray material/ha, 59 and 74 days after planting. Rhizoctonia solani grain inoculum was applied in the crowns one day after the first spray application. Incidence and severity of crown rot increased until harvest. On 17 Sept. the following treatments showed significantly less crown rot than the control which = 51.4%: Benlate 50 W + Du-Ter 47.5 W tank mix (1.9 g + 1.9 g/100-m of row), and Bravo 500 F (20 ml). Other treatments included: Benlate 50 W (3.8 g); Benlate 50 W + Manzate 200 80 W tank mix (4.9 g + 19.9 g); DPX 770-2 77 W (19.9 g); Du-Ter 47.5 W (1.9 g, 5.0 g); OAC 3289 35 L (25 ml); OAC 3289 + PCNB 17 L + 17 L (25 ml).

b) Phoma seed infection - Two seed lots of US H20 showing high levels of Phoma betae infection were treated with fungicides applied either as aqueous slurries or liquid concentrates. Subsequent Phoma infection was determined by immersing seed units in 0.5% NaOCl for 5 min and plating out on water agar. The effectiveness of treatments in reducing seedling infection was determined by planting seed in sand flats and in field plots. Nineteen treatments were tested.

Phoma infection in treated seed lots ranged from 0 - 52%. The two non-treated control lots showed 30 and 77% infection. The following treatments were rated as superior in reducing infection: Prochloraz 40 EC (160 ml/100 kg), OAC 3289 + PCNB 17 + 17 L (65.2 ml); OAC 3289 + OAC 2718 35% + 2% L (326 ml); Lesan 75 W + Captan 75 W (219 g + 750 g); Lesan 70 W + Terracoat SD 205 (219 g + 750 g); Lesan 70 W + Prochloraz 25 W (219 g + 250 g). The following were rated as superior in the sand box test: Lesan 70 W + Benlate 50 W (219 g + 100 g); Lesan 70 W + Captan 75 W; Lesan 70 W + Prochloraz 25 W; Prochloraz 40 EC (163 ml); OAC 3289 + OAC 2718 35% + 2%; Lesan 70 W (250 g). In the field test, soil conditions were warm and extremely dry with little evidence of seedling disease caused by soil-borne and seed-borne pathogens, and none of the treatments resulted in stands greater than the untreated control.

c) Fungigation experiment - Fungicides were applied through irrigation sprinklers to plots of US H20 exposed to inoculum of Cercospora beticola and Rhizoctonia solani. Commencing 1 July, there were 10 applications at weekly intervals of the following composed treatments: Benlate 50 W (560 g/ha); Bravo 500 F (731 ml), and Du-Ter 47.5 W (700 g). In untreated control plots, the mean leaf spot severity index = 3.4 (0-9) and crown rot index = 23 (0-100). Each fungicide treatment significantly reduced leaf spot infection. Bravo and Du-Ter significantly reduced crown rot.

d) Storage rot - Mertect 340 F, Prochloraz 25 ED, and Ronilan 50 W fungicides were tested at rates of 250, 500, 1000, and 1500 ppm for efficacy in controlling storage rot fungi, Botrytis cinerea and Phoma betae. Cubes, 1-cm^3, cut from sugarbeet roots were dipped in the fungicide suspensions, dried, then placed on the surface of petri-dish cultures of each pathogen. After a 10-day incubation period, the cubes were sliced longitudinally, and the degree of rot was ascertained.

Each of the 3 fungicides at each concentration, significantly reduced Botrytis rot, with Ronilan 50 W rated superior. Prochloraz and Ronilan each significantly reduced Phoma rot at each concentration, whereas none of the concentrations of Mertect were effective.

2. The Use of Aerial Photography to Estimate Root Rot Damage in Sugarbeet Plots.

C. L. Schneider and G. R. Safir

During the period 1974-78, we obtained eight aerial photographs of sugarbeet plots exposed to Aphanomyces black root and Rhizoctonia crown rot diseases. The photographed areas comprised: a black root nursery where plots were exposed to natural occurrence of Aphanomyces cochlioides; crown rot nurseries, inoculated with grain cultures of Rhizoctonia solani; and crop sequence plots naturally exposed to both pathogens. The plots comprised breeding lines being screened for disease resistance and plantings of commercial cultivar US H20 in experiments to test efficacy of various fungicides and cropping systems. Among the 30 experiments involved, there was a wide range of disease intensities and in most cases there were significant differences among the entries. We have previously reported that photo estimates of disease damage are indicative of field evaluations (1, 2). In this report we summarize our subsequent studies on the use of aerial photography in evaluating root disease damage in sugarbeet.

Methods and Materials

Previous studies have shown that false color infrared film, by providing greater contrast between plots at different disease severity levels, was better suited for our purpose than natural color film. The plots were photographed on 35 mm IR Ektachrome film with a motor-driven camera equipped with a 50 mm lens and a Wratten 12 filter. Photos were obtained at altitudes from 230 to 760 m and, in most cases, at a near 0^o ($\pm$ 5^o) view angle.

1) Schneider, C. L. and G. R. Safir 1975. Infrared aerial photography estimation of yield potential in sugarbeets exposed to blackroot disease. Plant Dis. Reptr. 59:627-631.
2) Schneider, C. L. and G. R. Safir 1976. Use of infrared aerial photography to evaluate disease severity in sugarbeet exposed to black root and crown rot diseases. Proc. Amer. Phytopathol. Soc. 3:245 (Abstract).

The 35 mm transparencies were viewed in a microfiche reader at 30 x magnification with resultant photo: ground scales of 1:147 to 1:345. Plots, which ranged from 5 to 20 mm length and 1 to 4 rows in width, were assigned numerical health ratings from 1 to 10 according to quantity and quality of observed biomass. Quantity was indicated chiefly by stand. Quality was indicated by color, which varied from deep red (healthy), through various shades of red to pink (moderate to severe infection), to white (plants moribund or dead). In the eight photos we obtained, we evaluated a total of 3407 plots.

Results

Photo health ratings correlated well with ground-based plot health ratings (100-pct disease), with highly significant r values that ranged from .62 to .93. In plot areas where plants were under noticeable stress from factors other than disease - such as low soil moisture and nutrient deficiency - correlation was considerably less than in areas where the problems were not so apparent.

Among the 30 experiments analyzed, there were significant differences in mean health ratings of the entries in 19 of the 25 experiments that had significant differences in ground-based ratings. Among 263 entries that received superior ground-based health ratings, 161 (61.2%) received superior photo health ratings.

Summary

Aerial IR color photos permit the researcher to make rapid preliminary estimates of disease intensity and over-all correlations of field plots comprising relatively large areas. Experiments with significant differences in disease intensity among entries can be readily identified. In addition, aerial photos provide a permanent pictorial record of an entire field experiment that can be analyzed in detail after opportunity to study the actual crop has passed.

BREEDING SUGARBEETS FOR RESISTANCE TO BLACK ROOT AND LEAF SPOT

G. E. Coe

Research work on sugarbeets at the Agricultural Research Center, Beltsville, Maryland is directed toward varietal improvement of sugarbeets resistant to Aphanomyces black root and Cercospora leaf spot, important diseases in eastern United States.

Testing for Leaf Spot Resistance

A good leaf spot epidemic occurred in the early planted 1979 Beltsville leaf spot nursery. A moderate epidemic occurred in later planted plots. Results of these tests are presented in Tables 1 and 2.

TABLE 1. Results of leaf spot tests in early planting at Beltsville in 1979.

Expt. No.	Description	No. Lines Tested	Av. Leaf Spot Rating*		
			Av. of Breeding Lines	USH20 Check	Exptl. Hybrid Check
1 & 11	Black Root & Leaf Spot resistant MM lines from Beltsville	67	3.4	5.0	3.1
2	BRR-LSR mm lines from Beltsville	33	3.4	5.7	3.7
Misc.	MM Smooth-root progenies	247	4.1	5.8	4.0
Misc.	F_1 of soil-free X smooth root	234	3.6	5.3	-
Misc.	F_2 of soil-free X smooth root	70	4.6	5.3	-

* 0 = No spots; 10 = All leaves dead.

TABLE 2. Results of leaf spot test in late plantings at Beltsville in 1979.

Expt. No.	Description	No. Lines Tested	Av. Leaf Spot Rating *		
			Av. of Breeding Lines	USH20 Check	Exptl. Hybrid Check
3 & 4	MM from E. Lansing	46	3.8	5.0	3.3
5 & 12	Rhizoc resistant mm from E. Lansing	88	3.2	4.9	2.7
Misc.	MM Smooth-root progenies	243	3.1	5.1	2.7
Misc.	MM Soil-free progenies	84	3.8	5.0	-
Misc.	F_1 Soil-free X Hi-sugar beets	48	2.7	5.0	-
Misc.	F_2 Soil-free X smooth-root sugarbeet	52	2.9	5.0	-

* 0 = No spots; 10 = All leaves dead.

The data indicated a good level of leaf spot resistance in the breeding material compared with USH20. Only the soil-free breeding lines, however, exhibit improved resistance over soil-free breeding lines tested the previous 2 or 3 years. The other breeding material was expected only to maintain good levels of resistance, because selection pressure for resistance has been relaxed in favor of selection for increased yield. Present levels of leaf spot resistance in the breeding material are believed to be adequate to prevent noticeable sugar losses in Michigan and Ohio.

Testing for Black Root Resistance

Tests for resistance to Aphanomyces black root were conducted in the winter of 1978-79. There was a big variation in the severity of the epidemic from experiment to experiment. When the epidemic is too severe, the lines being tested appear relatively susceptible compared with our resistant check. When the epidemic is relatively mild many of the tested lines appear to approach the resistance of the resistant check. One phenomenon was quite noticeable in the 1978-79 tests: the occurrence of occasional progenies that were quite susceptible to black root. This may have been caused by outcrossing to susceptible lines present 2 or 3 years ago. The susceptible progenies were eliminated from further utilization by the results of the black root test, but cause the breeder some concern regarding the origin of the susceptibility. The results of the blackroot tests are presented in Table 3.

TABLE 3. Results of black root tests at Beltsville in 1978-79.

Description	Number of Lines Tested	Black Root Rating * Av. of Lines Tested	Resistant Check	Susceptible Check
MM progenies from Leaf Spot Selections	71	109	100	113
MM progenies from Black Root Selections	131	99	100	105
MM progenies from Growth Chamber Selections	48	101	100	107
MM progenies from Smooth Root selections	128	105	100	114
mm Self-compatible Progenies	23	120	100	115
mm Self-incompatible Progenies	107	105	100	117

* Minimum - Maximum Possible Ratings: About 78 to 132
Low rating = high resistance to black root.

The average black root rating of two groups of material in Table 3 was poorer than expected and may be partially related to the erratic behavior of the resistant check varieties. The monogerm self-compatible progenies, however, were more susceptible because inbreeding depression was affecting speed of germination and seedling vigor. The MM progenies from leaf spot selection (1st item in Table 3) should have exhibited more resistance. It is hoped that this apparent decline in resistance is not real, but a result of erratic testing conditions. Hence, it is necessary to take a critical look at the testing procedure and conditions to determine if there are now flaws in what has appeared to be a good technique.

Breeding for Soil-free Roots

Breeding for soil-free beets has been undertaken from 2 sources: (1) selecting in a sugarbeet line for relatively clean roots (called smooth-root selection); and (2) backcrossing sugarbeet-garden beet hybrids to sugarbeets and selecting for "soil-free" roots (called soil-free selections). Progenies from soil-free selections have been best in being free from adhering soil when harvested. However, there is considerable variation in the amount of adhering soil among roots of each progeny; but the worst roots have much less soil clinging to them than the best roots of USH20. Only the lower content of sucrose has been keeping the soil-free lines from becoming components of commercial hybrids. Results from the 1979 Beltsville nursery trials contain encouraging indications that the sucrose content of soil-free breeding lines is increasing. The term "indications" is used because an

experiment was not set-up to specifically test soil-free beets for their performance in surcrose percentage. However, there were planted in the same nursery plot the following material: (1) 46 progenies of smooth-root selections from which 243 roots selected for freedom from adhering soil were analyzed; (2) 10 F_2 progenies of soil-free smooth-root hybrids from which 52 selected roots were analyzed; (3) 6 F_1 soil-free X high sucrose sugarbeet progenies from which 48 selected roots were analyzed; (4) 10 soil-free progenies without recent backcrosses to sugarbeets from which 84 selected roots were analyzed; (5) SP7822-0 from which 584 unselected roots were analyzed; (6) 14 experimental hybrids each of which had 6 replicated 8-root samples analyzed for sugar. The SP7822-0 was a special experiment in which the seeds were hand planted at 16 inch spacing down the row. Every root was analyzed for content of sucrose and nonsucrose solubles. The experimental hybrids were planted at a 4 inch down-the-row spacing, and the other material was planted at a 6 inch down-the-row spacing. All rows were 2 ft. apart. The results of these analyses are presented in Table 4.

TABLE 4. Sucrose and nonsucrose solubles data from 1979 Beltsville Nursery Plot SG-12.

		Analyzed Roots				
Group No.*	Description	No. Rts. Analyzed	Av. Rt. Wt.	Av. % Sucrose	Av. % NSS**	Av. Leaf Spot Resistance
1	Smooth-root Progenies	243	3.1	11.5	2.15	3.08
2	F_2 of Soil-Free X Smooth Rt.	52	2.9	12.4	2.16	2.90
3	F_1 of Soil-Free X Hi-sugar MM	48	3.1	12.7	2.00	2.70
4	Soil-Free Progenies	84	3.2	9.6	2.39	3.77
5	SP7822-0	584	3.2	11.8	2.56	3.00
6	14-Experimental Hybrids	(8X84)	2.0	11.4	2.79	3.67

* Refers to groups described in above paragraph.
** Nonsucrose solubles

The average sucrose percentage of group 4 in Table 4, soil-free progenies with fewer backcrosses to sugarbeets, was appreciably lower than the other groups. Higher leaf spot susceptibility can account for some of this, but it is believed that it is inherently lower than groups 2 and 3 which have had more backcrossing to sugarbeets. Roots of SP7822-0, group 5, might have had slightly higher sucrose content had they been grown at 6 inch spacing rather than 16 inch. However, this is by no means certain. The relatively higher average sucrose content and lower average content of nonsucrose solubles of groups 2 and 3 are very encouraging. Although the soil-free characteristic has not been developed to its maximum potential (that is the breeding lines still segregate into root classes ranging from

little adhering soil compared to commercial hybrids to almost no adhering soil), this germplasm probably will be useful in improving parental lines of present day hybrids, and perhaps may be useful as parental lines themselves.

Growth Chamber Selections for TLWR

F. W. Snyder's work on selecting sugarbeet seedlings in his growth chamber for high taproot weight relative to leaf blade weight (high TLWR) showed that productivity of a breeding line could be improved. In some test plots the progeny of TLWR selections produced higher root yields than the parental line without any decrease in sucrose percentage or purity. In other tests there was no difference between the two in root yield, but progeny of the high TLWR selections had higher sucrose percentage and better purity.

I made 2 successive selections in SP6922-0 for high TLWR. I crossed roots of the 2nd selection with 6 different male-sterile lines and tested the hybrid progeny in a replicated test against comparable hybrids from the pollen parental line or against hybrids of a closely related derivative of the original pollinator. The field test consisted of 4 replications of each hybrid. Each replication consisted of 4 rows 20 ft. long. The center 2 rows of each plot was harvested and the first 8 roots in the row large enough for analyzing were taken for a sugar sample. Results of this test are presented in Table 5.

TABLE 5. Results of TLWR experimental hybrid test in the 1979 Beltsville field trial.

Variety	Av. Leaf Spot Rating	No. Rts/A Harvested	Ton/A Rt Wt.	Av. % Sucrose	Av. % SNSS
77610-01 X 77254-m Sel*	4.33	24,000	14.30	10.3	2.21
77610-01 X 6922-0	3.93	20,700	14.75	11.7	3.09
Difference	+ .40	+ 3,300	- .45	- 1.4	- .88
77612-01 X 77254-m Sel	3.50	17,400	16.89	11.1	2.62
77612-01 X 6922-0	3.75	20,700	15.88	11.2	2.94
Difference	- .25	- 3,300	+ 1.01	- 0.1	- .28
77576-01 X 77254-m Sel	4.33	21,600	15.78	10.3	2.99
77576-01 X 7622-0	3.93	20,000	15.48	11.3	2.67
Difference	+ .40	+ 1,600	+ .30	- 1.0	+ .32
70682-01 X 77254-m Sel	3.50	21,000	14.60	11.6	2.97
70682-01 X 77288-0	3.33	21,100	15.37	11.4	2.58
Difference	+ .17	- 100	- .77	+ 0.2	+ .39
70745-02 X 77254-m Sel	4.33	20,000	14.10	10.3	2.78
70745-02 X 6922-0	4.17	20,800	15.39	11.2	2.65
Difference	+ .16	- 800	- 1.29	- 0.9	+ .13
77550-01 X 77254-m Sel	2.75	16,200	16.08	11.4	2.93
77550-01 X 6922-0	3.00	22,500	16.29	13.2	3.10
Difference	- .25	- 6,300	- .21	- 1.8	- .17
Checks					
USH20	5.08	27,600	14.65	10.9	2.43
75576-01 X 74409-7	3.42	17,800	17.39	11.7	2.70
75550-01 X 6822-0 Pow. Mil. Res.	3.08	20,300	17.42	12.2	2.86

* SP77254-m Sel = Second generation TLWR Selection

Low root yields and low sucrose percentage can be attributed to late planting and abundant moisture throughout the growing season. There was little difference in root yields between the experimental hybrids from the TLWR selection and hybrids of the original parents. Sugar percentages were lower in 5 of the experimental hybrids. The other solubles were higher in some and lower in others. It can be concluded that this particular TLWR pollinator selection did not produce superior hybrids. Perhaps when it is crossed with a MS line that has also been selected for high TLWR the results will be different. Perhaps other pollinator lines selected for high TLWR will give different results, but thus far my TLWR selections have not increased yield.

Cold Temperature Seed Germination

Two successsive cycles of selection were made from plant progenies whose seedlings emerged rapidly at 48°F. Seed increases were made in the growth chamber from plants of the second selection. Seed from these increases (SP78801-number) were planted in the cold frame on March 9, 1979. USH20 and seven unrelated and unselected multigerm plant progenies (SP78301-number and SP78302-number) known to germinate well in the greenhouse were planted as checks. Soil temperature from March 8 to March 28 at 3/4 inch depth ranged from below freezing to 8°C at 8:00 a.m. and from below freezing to 24°C at 4:00 p.m. The 4:00 p.m. soil temperature at seed depth was not consistently above 10°C until after March 17. The number of seedlings emerged is shown in Table 6.

TABLE 6. Number of Seedlings Emerging in 1979 Cold Frame Germination Test.

Variety	No. of Seedlings Emerged On										
	3/17	3/18	3/19	3/20	3/21	3/22	3/23	3/25	3/26	3/27	4/6
USH 20 Repl.#1							0	1	4	5	50
USH 20 Repl.#2							0	3	7	7	44
USH 20 Repl.#3							0	1	3	6	34
USH 20 Repl.#4							0	3	11	15	32
78301-4							0	52	54		
78301-12					0	2	2	68	80		
78301-37				0	12	46	55	89	87		
78302-14							0	49	67		
78302-16					0	16	33	87	86		
78302-30				0	1	32	48	80	77		
78302-67				0	1	49	64	90	88		
78801-04					0	4	5	47	48		
78801-05					0	1	8	60	67		
78801-06				0	1	26	36	70	75		
78801-07					0	4	5	46	54		
78801-08					0	1	2	41	43		
78801-09				0	1	8	17	52	52		
78801-010					0	2	7	16	22		
8:00 a.m. Soil Temp. °C	2	0	0	2	4	4	6	6	2	0	-
4:00 p.m. Soil Temp. °C	14	-	16	18	20	24	19	-	-	-	-

The factors affecting rate and percent of sugarbeet seed germination are complex. Some research indicates that it might even be affected by the soil conditions under which the parent plants produced the seed. In Table 6 it can be observed that seed of USH20 was the slowest and poorest germinating seed of those tested. This is probably due to the age of the seed, it being 3 or 4 years older than the others. Four of the 7 check varieties SP78301-37, SP78302-16, SP78302-30, and SP78302-67, germinated better and more rapidly than all except two lines selected for rapid germination at cold temperature. This would indicate the selections were not effective. However, the selected plants were placed in a growth chamber with lights considerably lower in intensity than natural sunlight to produce seed. It is possible that seed produced under this condition are "weak" from a deficit of nutrition during their development. A final judgment will not be made until seed from plants selected from the cold frame test are increased in a field plot and then tested in the cold chamber and the cold frame.

Development of Tissue Culture Techniques

We are trying to develop a tissue culture technique in order to produce haploid plants from anthers. This past year 32 different media were tested using a total of 350 flowers from 120 different plants. In addition dark treatments and temperature variations were explored. The most critical factor seems to be the medium used. From our most recent medium we have been able to obtain good callus growth from ovary tissue, anthers that will swell to many times their original size, and some callus tissue produced from 1 anther. It is too early to determine whether this callus is haploid or diploid. In any event, the recent results are encouraging. We have hopes of a breakthrough with this work in the near future.

Monogerm O-Types

Only 3 new monogerm O-types were discovered in 1979. These were tested for leaf spot resistance in the nursery and were reasonably resistant. Seed increases of these are being made this summer.